Gamry Instruments Software

Getting Started Guide

Revision 4.2
May 5, 2003

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Gamry Instruments, Inc. cannot guarantee that the Software described in this guide or its associated potentiostat(s) will work with all computer systems, operating systems, or third party expansion cards and peripherals.

The information in this manual has been carefully checked and is believed to be accurate as of the time of printing. However, Gamry Instruments, Inc. assumes no responsibility for errors that might appear.

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If You have Problems

Contact us at your earliest convenience. We can be contacted via:

Telephone	(215) 682-9330 8:15 AM - 6:00 PM US Eastern Standard Time
Fax	(215) 682-9331
Email	techsupport@gamry.com
Mail	Gamry Instruments, Inc. 734 Louis Drive Warminster, PA 18974 USA

If you write to us about a problem, provide as much information as possible.

If you are having problems in installation or use of the software, it would be helpful if you called from a phone next to your computer, where you can type and read the screen while talking to us.

We will be happy to provide a reasonable level of free support for registered users of Gamry Software and Electrochemistry Systems. Reasonable support includes telephone assistance covering the normal installation, use and simple programming of systems using the Gamry Software on standard computer hardware.

We provide one year of free software updates. A service contract that extends both the hardware warranty and software update period is available at an additional charge. Software updates do not include software enhancements offered to our customers at additional cost.

Enhancements to the Software and Electrochemistry Systems that require significant engineering time on our part can be performed on a contract basis. Contact us with your requirements.

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Chapter 1 -- Introduction

Description of this Guide

This *Getting Started Guide* is primarily a software installation manual. It covers the installation of all Gamry's Framework based software packages including:

- The Gamry Framework
- The Echem Analyst
- The DC105 Corrosion Measurement System
- The CPT110 Critical Pitting Temperature System
- The EN120 Electrochemical Noise Measurement System
- The PHE200 Physical Electrochemistry System
- The PV220 Pulse Voltammetry Software
- The EIS300 Electrochemical Impedance Spectroscopy System
- The FC350 Fuel Cell Monitor

This Guide also covers installation of Gamry's Labview™ based software packages including:

- The ESA400 Electrochemical Signal Analysis System
- The VFP600 Virtual Front Panel

Short descriptions of both the Framework based and the Labview based software packages can be found in Chapter 3 (Software Descriptions).

This Guide was written to go with Revision 4.2 of the Gamry software. Installation instructions described here will not work with earlier revisions of Gamry's software. We anticipate these instructions will work with all later revisions (for example Revision 4.25 if it is ever needed).

Revision 4.2 of the Gamry Software has been designed to operate with the new Gamry PCI4/300, PCI4/750, and FAS2 Potentiostat/Galvanostat/ZRAs. It will also work with Gamry's older PC4/300, PC4/750 and FAS1 Potentiostat/Galvanostat/ZRAs. It will not work with Gamry's older PC3 family instruments.

> NOTE: The FC350 is a special case. It will not operate with any of the standard Gamry potentiostats listed above. It interfaces to a high current load or power supply which then controls the electrochemical cell under test. The Gamry hardware required for use with the FC350 is the FC4 or FCI4 Fuel Cell interface.

What's New?

The most important changes in both the software and in this document concern the addition of the PCI Family of potentiostats (the PCI4/300, the PCI4/750, and the FAS2). These devices all interface to a computer using the PCI bus and are inherently Plug & Play compatible. This simplifies the setup of systems that only contain these devices.

Unfortunately, it did not simplify this guide, because a description of both PC4 and PCI4 family devices is required.

This Guide also covers installation of two new systems – the FC350 Fuel Cell Monitor and the PV220 Pulse Voltammetry software.

What is not in this Guide

This Getting Started Guide does not describe Gamry's hardware. Descriptions of Gamry's Potentiostats, Temperature Controllers, and Multiplexers can be found in the Gamry Hardware User's Manual.

This Guide is intentionally limited in some areas. It is not a Microsoft® Windows™ manual. It would be foolish for us to duplicate Microsoft's excellent tutorials and manuals. Please consult the Microsoft manuals or tutorials if you need more information on specific aspects of any of the supported Windows revisions.

Help files included with each software package are the primary technical support tool for Gamry's software. The material in these Help files is very complete compared to Help files for most other Windows applications. Very little of the information in Help is duplicated in this Guide.

Help is also the gateway to access the on-line tutorials that come with several of the Gamry Framework application software packages. These tutorials provide quite comprehensive training in both basic use of the software and advanced techniques.

Notational Conventions

In order to make this manual and the online help more readable we have adopted some of Microsoft's standard notational conventions and added some of our own. These are used throughout this and other Gamry Instruments' manuals.

- Key names. The names of keys are spelled out in this manual (for example ESCAPE, ENTER, CONTROL) and appear as small capital letters. The key caps on your keyboard may abbreviate the names or represent them differently. For example, the ESCAPE key is often labeled Esc and the ENTER and TAB keys are often labeled with arrows.
- Key combinations. A plus sign between two characters indicates that the keys are pressed at the same time. An example is ALT+ESCAPE to switch between windows.

  A comma between key names indicates that the keys are pressed sequentially, pressing and releasing one key before pressing the next key.
- DIRECTION keys. The DIRECTION keys are the four pointing keys, labeled with arrows, on your computer's keypad. The name of the individual DIRECTION key refers to the direction the key points: UP, DOWN, RIGHT and LEFT.
- Italics. *Italics* indicate words and characters that you type.
- Numbered lists. A numbered list is reserved for step-by-step procedures, with the steps always performed sequentially.
- Bulleted list. The items in a bulleted list, such as this one, are grouped together because they represent similar items. The order of items in the list is not critical.
- Hexadecimal numbers. Hexadecimal numbers are used for hardware related items such as I/O addresses. The Framework and this manual use the C programming language convention: all hexadecimal numbers have a prefix of 0x. For example the default I/O addresses used by a PC4 Potentiostat card are 0x120 through 0x13F.
- File names and directories. Inside paragraphs, references to files and directories will be in quotes, for example: "gamry.ini" and "\FRAMEWORK\FRAMEWORK.EXE".
- Windows buttons and menu selections. Labels will be shown in bold type with the accelerator key underlined as shown on the screen, i.e., **File**.

Chapter 2 – Installation

Overview

Gamry Instruments' Electrochemical Measurement Systems include both electronic hardware and computer software that need to be installed in a computer. If you purchase a complete application system with a computer, Gamry Instruments, Inc. will install the system components for you to produce a "turn-key" system.

If you buy your own computer, you need to know how to install the software. All Gamry's software is provided on a single Gamry Software CD. This guide describes the software installation process in detail.

The software that is installed includes drivers for both Gamry's PCI based PCI4 potentiostat family and Gamry's older ISA based PC4 potentiostat family. The drivers are installed during software installation.

Physical installation of your potentiostat hardware is described in the Operator's Manual that accompanied your potentiostat(s).

Installation Order

You should install Gamry's Windows software before you install any hardware into your computer.

If you install a PCI4 family potentiostat before installing any software, the Windows device manager will complain about "Unknown Hardware Device Found" or "Unknown PCI Bridge Device Found".

If this occurs, cancel the configuration of this unknown device and proceed with software installation. The error message should not reappear when you restart your computer.

General System Requirements

If you are installing Gamry Software into your own computer you must be aware of the following universal system requirements. Applications Software systems may have specific requirements beyond these general requirements. The general requirements are:

- A computer based on one of the Intel Pentium family of microprocessors or a 100% compatible processor.
- Microsoft Windows 98™, Windows Me™, Windows 2000™, or Windows XP™ installed on the computer's hard disk. Revision 4.2 will not work with Windows 95™ or any earlier revision of Windows.
- At least 128 Mbytes of RAM memory and 120 Mbytes of free hard disk space in your computer.

In addition, a Gamry system requires Gamry Instruments, Inc. potentiostat (or Fuel Cell Interface) if it will make electrochemical measurements. This potentiostat is normally sold as a part of a complete Electrochemical Measurement system.

Gamry Instruments makes several different potentiostats. The computer requirements for each potentiostat may differ. Consult your potentiostat's Operator's Manual for these additional computer requirements.

Computer Influence on Data Acquisition Speed

The data acquisition speed of Gamry's potentiostats is dependant on the clock speed of the computer and the amount of extra computer activity occurring during curve acquisition. A 400 MHz Pentium III computer probably will not take data reliably at Gamry's recommended minimum sampling time (100 μsec per point) especially if you opening new programs, perform large disk or network transfers, or play computer games while data is being acquired. Slower acquisition relaxes the computer's speed requirements, but we recommend you minimize computer activity whenever you take data at less than 1 msec per point.

Even with a seemingly idle computer, Windows can occasionally fail to service an interrupt quickly enough, resulting in an errant data point. Gamry's Framework software will always detect an error of this type on a PCI4 class potentiostat. We call this error an interrupt overrun. When an overrun is detected, the errant data point is labeled as suffering from an interrupt overrun and curve acquisition is continued. The overrun point is not displayed in either the real-time curve or the EChem Analyst, although it is kept in the data file as a record of the overrun event.

If the number of data points with overruns exceeds a reasonable criterion, the user is informed of the problem. The criterion depends on the experiment being performed and the number of points in that experiment. One overrun data point will cause an error message on a ten point experiment. One bad data point can generally be omitted from a ten thousand point curve.

We expect overrun errors to be very rare. At the time this is being written, a Pentium IV processor running Windows XP at 2.66 GHz, showed no overruns in over one million data points taken at 100 μsec per point, even when "extra" programs were opened during the data acquisition process. At 50 μsec per point, one or two overruns were seen in a sixty thousand point curve, when the system was stressed by opening the Echem Analyst or Internet Explorer during curve acquisition. No overrun errors were seen when the Framework was run by itself, even at 50 μsec per point.

Potentiostat Configuration

This guide describes system configuration of systems containing potentiostats from two different families. The first family will be referred to as the PCI4 family. It interfaces to a computer using the PCI bus. Its members include the PCI4/300, the PCI4/750 and the FAS2 Potentiostat/Galvanostat/ZRAs. The FCI4 Fuel Cell Interface, while it is not strictly speaking a potentiostat, also belongs in this family.

The second potentiostat family will be referred to as the PC4 family. It interfaces to a computer using the ISA bus. Its members include the PC4/300, the PC4/750 and the FAS1 Potentiostat/Galvanostat/ZRAs. The FC4 Fuel Cell Interface, while it is not strictly speaking a potentiostat, also belongs in this family.

Devices in the PCI4 family are Plug & Play compatible. The Windows Device Manager does their hardware configuration automatically. There is only one set of jumpers used to configure the potentiostat. These jumpers control the characteristics of the rarely used Auxiliary A/D input.

Devices in the PC4 family are only partially Plug & Play compatible. The Windows Device Manager can only set the interrupt level automatically. DIP-switches on the potentiostat may have to be reset to configure the potentiostat for use in a specific computer system. Fortunately, in most cases, you leave the switches in their factory set positions and forget they are there.

Multiple Potentiostat Systems

Gamry's current Framework software (Revision 4.2) allows a computer to operate several Gamry Instruments potentiostats simultaneously. Setup and operation of a multiple potentiostat system that includes only PCI4 family potentiostats is very simple.

Gamry's Framework now contains a utility script to identify PCI4 Family potentiostats in a multiple potentiostat system. See Appendix C of this guide for instructions concerning the use of this program.

Initial setup of a system containing multiple PC4 family devices requires that you change DIP-switch settings one or more PC4 Controller cards. Once the DIP-switches have been set in a PC4 based system, you can reinstall Gamry software without making any hardware changes.

Systems can also include both PCI4 and older PC4 family devices in the same computer. This guide should give you enough information to setup a system of this type. We do recognize that configuration of this type of system can be quite complex. Contact our home office or your local sales representative if you need assistance setting up a system containing both PCI4 and PC4 family devices.

MultEchem™ Systems

Revision 4.2 contains provisions for a four or eight potentiostat system, known as a MultEchem™ system. MultEchem™ systems use only one system level software license instead of multiple potentiostat level licenses. The price of a MultEchem™ system is much lower than the price of a system using individual licenses.

A USB software key is used to authorize the operation of the system. Gamry's application software packages will only allow data acquisition on potentiostats that are in a computer that is connected to this key.

The MultEchem™ scheme does place some restrictions on the system and its purchase:

- The system must be ordered to include at least four potentiostats
- It must also include an industrial computer.
- All the potentiostats must be from the PCI4 Family (PCI4/300, PCI4/750, FAS2 or FCI350).
- The system must be installed at Gamry's factory.

A potentiostat removed from a MultEchem™ system cannot be used any other computer, unless the user either moves the USB key to that computer or purchases individual licenses for that potentiostat.

Software Installation

In Revision 4.2, software Installation for a typical Electrochemical Measurement System is very simple. You install the Gamry Framework program and any application programs using the Revision 4.2 distribution CD.

> Note: You should install Gamry's Windows based software <u>before</u> you install a potentiostat into your system.

<u>All</u> systems that include potentiostat hardware <u>must</u> install the Gamry Framework. This includes ESA400 and VFP600 Labview based systems. These systems use files from the Framework in their operation and use the Framework to calibrate the system's potentiostat.

Installing Windows

This manual does not cover installation of Microsoft Windows.

Most computers are supplied with a suitable version of Windows preinstalled. If this is not the case or you need to upgrade to a newer version of Windows, the Microsoft documentation describes the best installation procedures for their products.

Installation Media

The Gamry Software CD (CD-ROM) includes all of Gamry's Windows based software products.

The user can install all the software applications if he wishes. You can only acquired electrochemical data on applications that are authorized to run on the Gamry potentiostat in your system.

An HTML (standard Internet WWW protocol) page is used to provide access to Gamry's current Setup programs. Throughout these instructions, this page will be referred to as the HTML Setup page.

> **NOTE:** An Internet connection is not required to use this page. HTML is used as a "universal" tool to display this page and to link to Setup programs. All files required to install the Gamry software are contained on the CD.

A Web browser is required to use the HTML Setup page. Microsoft's Internet Explorer (included in all the Windows versions that run this revision of the Gamry software) is one suitable browser. Alternate browser's such as the Netscape Navigator should also function.

Contact Gamry if you cannot use a CD for software installation or if you do not have a Web browser loaded on your system.

Starting the Installation Process

Please run the Gamry Setup program as follows:

Start Windows.

Place the Gamry Distribution CD into your CD drive. (These instructions assume that you use CD drive D: If you use a different drive, such as E:, substitute the name of that drive wherever D: appears.)

If your CD drive is setup to Auto-run: The HTML Setup page should automatically appear in your Web browser.

If Auto-run is not enabled: From the Windows Taskbar (usually located at the bottom of the screen), select **Start, Run...** In the resulting dialog box, type

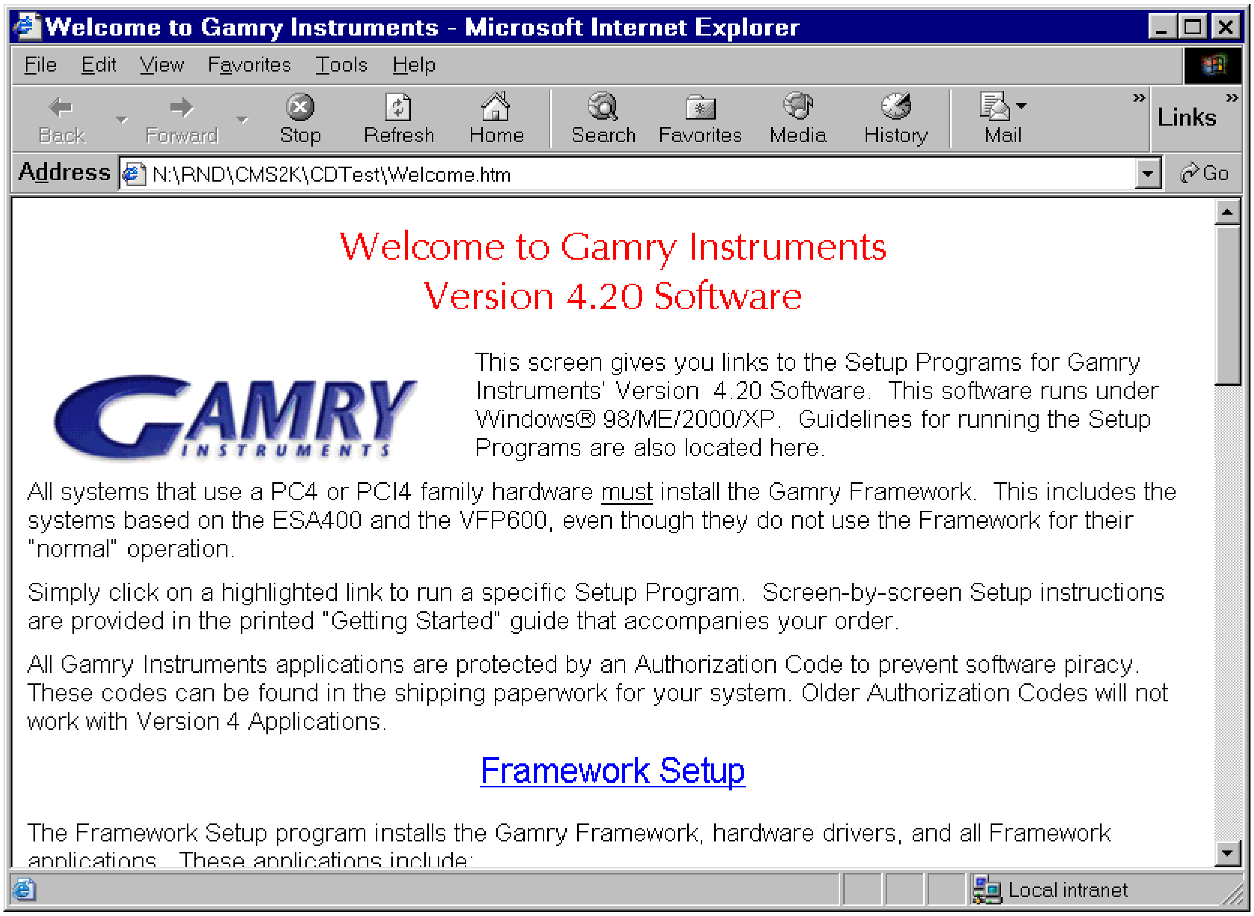
D:SWITCHBOARD

in the **Open** field. Select **OK**.

Figure 2-1 shows the HTML Setup page running in a version of Internet Explorer. The appearance in other browsers will be similar.

The HTML Setup page usually includes a vertical scrollbar – it is longer than most browser's Window.

Figure 2-1
HTML Setup Page in Internet Explorer



The text on the HTML Setup page and in dialog boxes within the Setup programs is intended to provide a knowledgeable user with enough information to install Gamry's software without referring to this written manual. It includes a description of the software to be installed and a discussion of which Setup program to run for a given system configuration.

The end of the HTML Setup page includes links to all of Gamry's printed documentation, in the form of PDF files. Even this document is available. The PDF files can be searched using tools in Adobe's PDF Reader, which can make them easier to use than the hardcopy versions.

> Note that all systems that include a potentiostat must install the Gamry Framework. No data acquisition is possible in systems that do not include the Framework. If the Framework is required on your system, your must run its Setup before running any other Gamry Setup.

The Gamry Echem Analyst should be installed on all systems running any Framework application package. The Analyst provides sophisticated data plotting and calculation capabilities needed in the Framework applications. The Analyst is not needed in systems that only use the ESA400 or the VFP600 for recording data files.

The ESA400 and VFP600 are compiled Labview applications. Each has its own Setup program.

There are links to the four Setup programs on the HTML Setup page. They are shown as blue

underlined, centered text on the page. Clicking the mouse on any of these Setup links will start the corresponding Setup program.

Once you have run all the Setup programs needed to install your software on your system, you can close your Internet browser to end the software installation process.

To close the browser, you can click on the X at the extreme upper-right corner of the browser window.

If you need to rerun the software installation at some point in the future, simply repeat Steps 1-5 above.

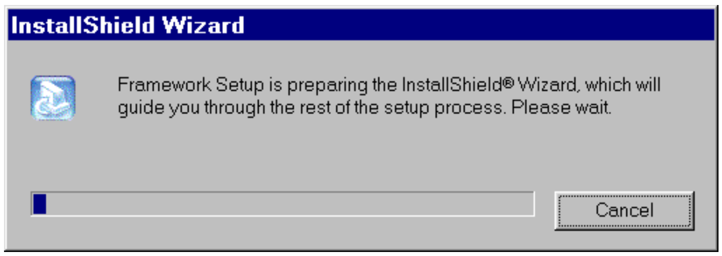
Framework Setup

The Gamry Framework must be installed on all systems that acquire electrochemical data using a Gamry Potentiostat.

The Framework Setup is generally started by clicking on its link in the HTML Setup page that is provided with the Gamry Software Distribution CD.

The first item that appears on the screen during the Framework Setup process is a message box (see Figure 2-2).

Figure 2-2
Install Shield Wizard Loading



After a few seconds, the display switch to a blue background with a white message in the upper-left corner of the screen. This message should read:

Installing Gamry Framework
Version 4.20
For Windows® 98/ME/2000/XP

or

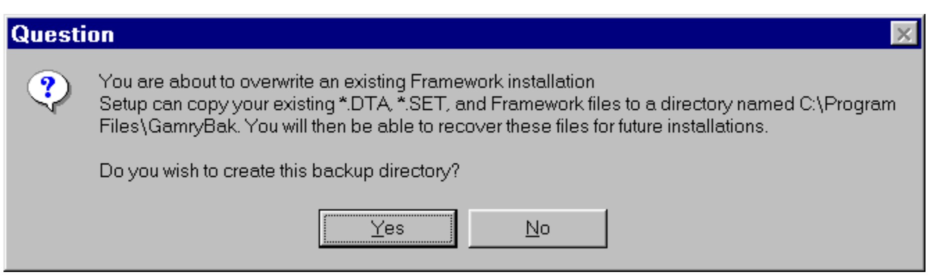
Reinstalling Gamry Framework
Version 4.20
For Windows® 98/ME/2000/XP

The version number may be greater than 4.20 if Gamry has updated the software on the CD to a later version. The blue background and message will remain on the screen as the following sequence of events occur:

1. If you are reinstalling the Gamry Framework on a computer that already includes Gamry software, you will be asked whether you wish to backup you data files, saved setup files and other Framework files. See Figure 2-3.

   In most cases, you should answer **Yes**. Saving old information while reloading software is usually a good idea.

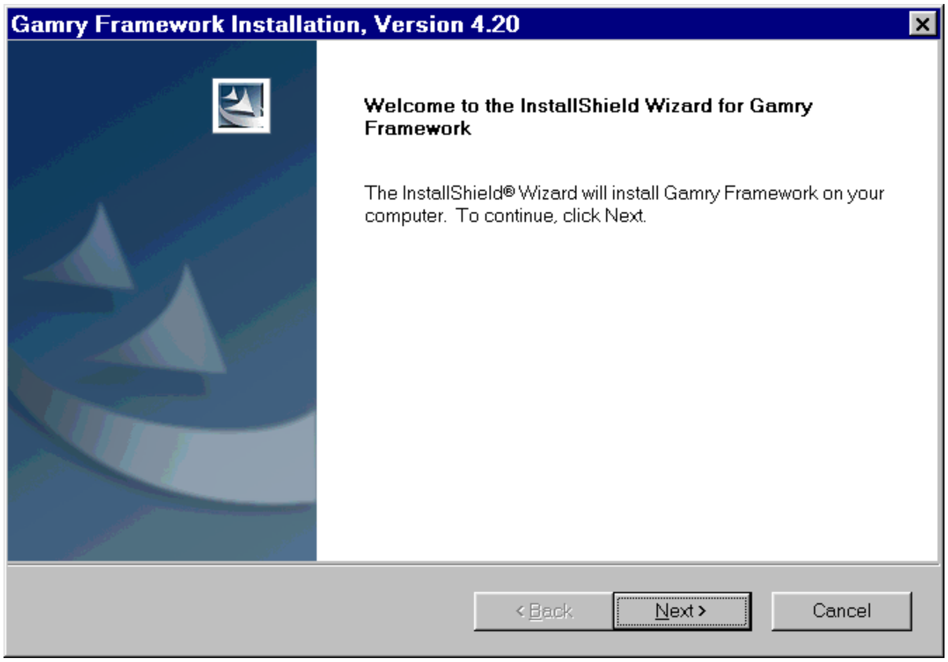
   Figure 2-3
   Save Old Settings



2. If you do not already have the Gamry Framework on your computer, you never see the dialog box in Figure 2-3. Instead, you go directly to the Welcome dialog box in Figure 2-4.

   This dialog box is the usual starting point for a Framework Installation. It is used to tell you what process is about to occur, and to give you a change to cancel that process. Press **Next**.

Figure 2-4
Welcome Dialog Box

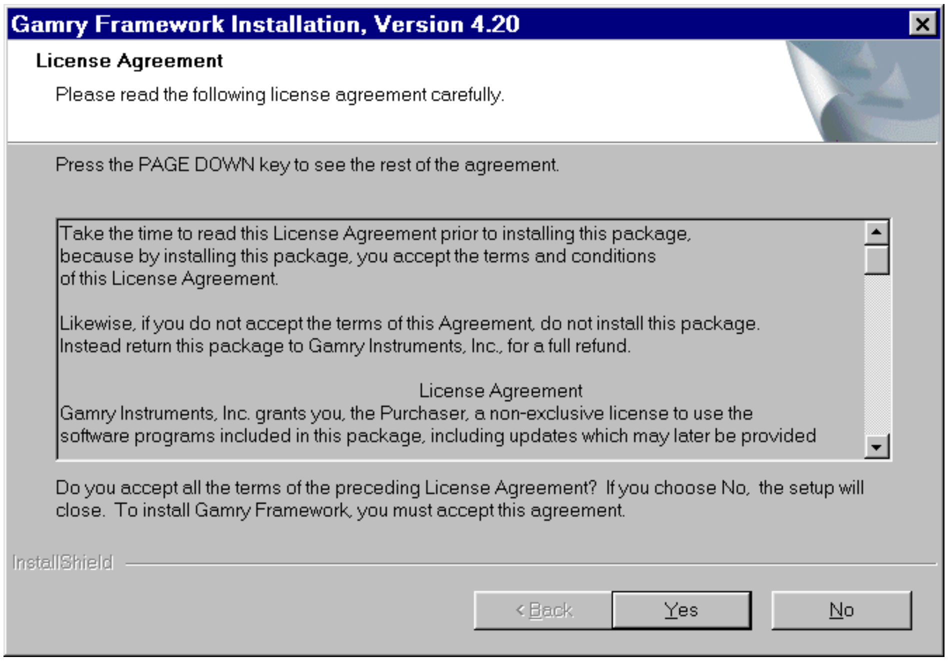


3. The next dialog box is Gamry Software license box (Figure 2-5). You must read the license statement in the text box and select **Yes** before you can install the Framework software.

   Selecting **Yes** commits you to obey the legal restrictions in the license agreement. The provisions in the Gamry Framework license agreement are standard terms generally found in commercial software licenses.

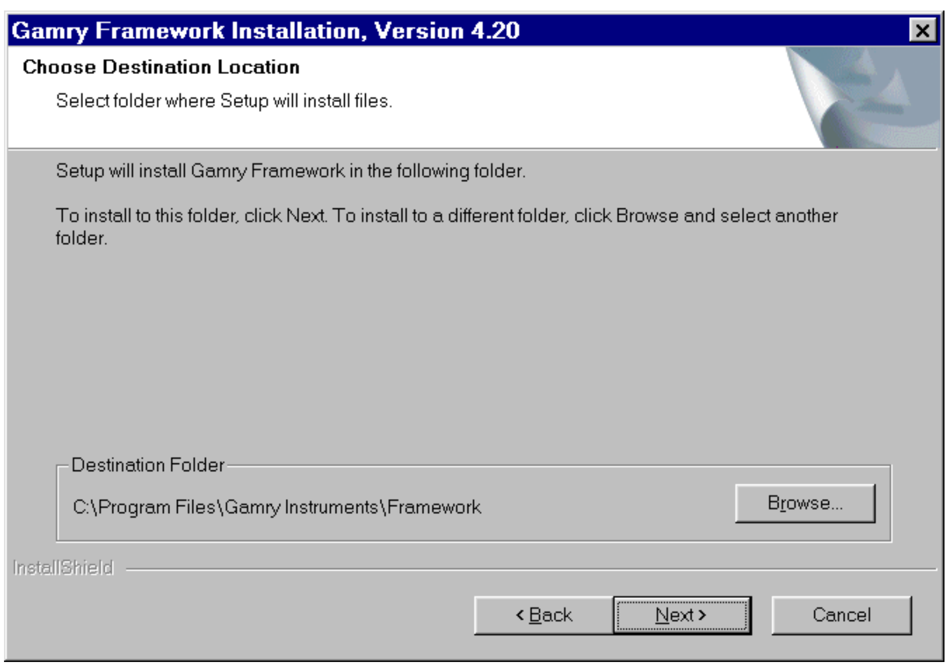
   If you disagree with any of the licensing provisions, you can select **No** in Gamry License dialog box and choose to not install the software. Once you do so, you can return the software for a full refund.

Figure 2-5
Gamry Framework License Dialog Box



15. Once you have accepted the Framework License, you will be asked to choose a destination directory for the installation of the Framework files (see Figure 2-6).

Figure 2-6
Gamry Framework License Dialog Box



Help files, script files, and results files all install in sub-directories of the disk directory chosen in this step.

We strongly recommend that you install into the default directory by selecting **Next**. Technical support for your system is much simpler if you use the default directory. Of course, we have tested the system for proper operation in other directories.

Alternate directories can only be chosen via the **Browse** function. This opens up a standard Windows File Selection Dialog Box, which will not be described here. Once you have selected a new destination directory, press **Next** to continue the installation process.

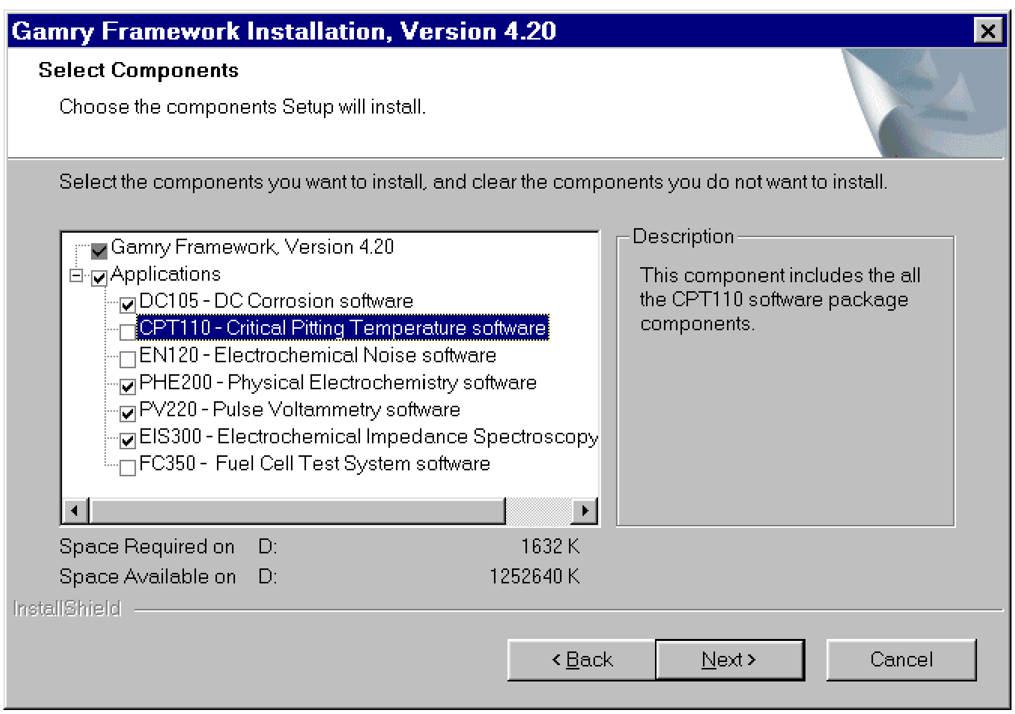
5. The next dialog box is seen in Figure 2-7. This dialog box allows you to select specific Framework applications for installation. Installation of an application takes up hard disk space on your computer, so you might only want to install applications that you will use.

   The selection of application software packages is made in a tree-like selector. All the applications shown with a check in their checkbox will be installed. Clicking the mouse on a checkbox toggles the state of that checkbox. You cannot unselect the Gamry Framework itself.

   The dialog box shown in Figure 2-7 has already been modified. The checkboxes for the CPT110, EN120 and the FC350 have been deselected.

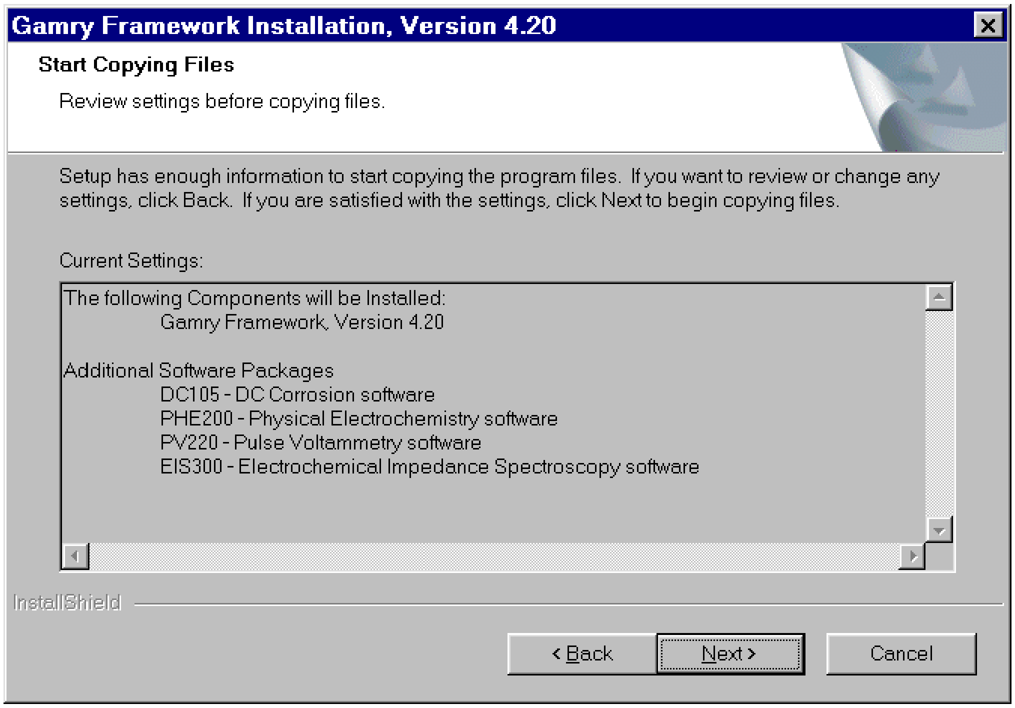
   NOTE: All of Gamry's Framework application packages require authorization before they will acquire electrochemical data. While you can install all Gamry's Framework applications on your computer's hard disk at this time, only those applications that are authorized for use with your hardware will operate.

Figure 2-7
Gamry Application Selection Dialog Box



6. The next dialog box (see Figure 2-8) lists your installation choices and asks you to confirm them prior to transferring files to your computer's hard drive.

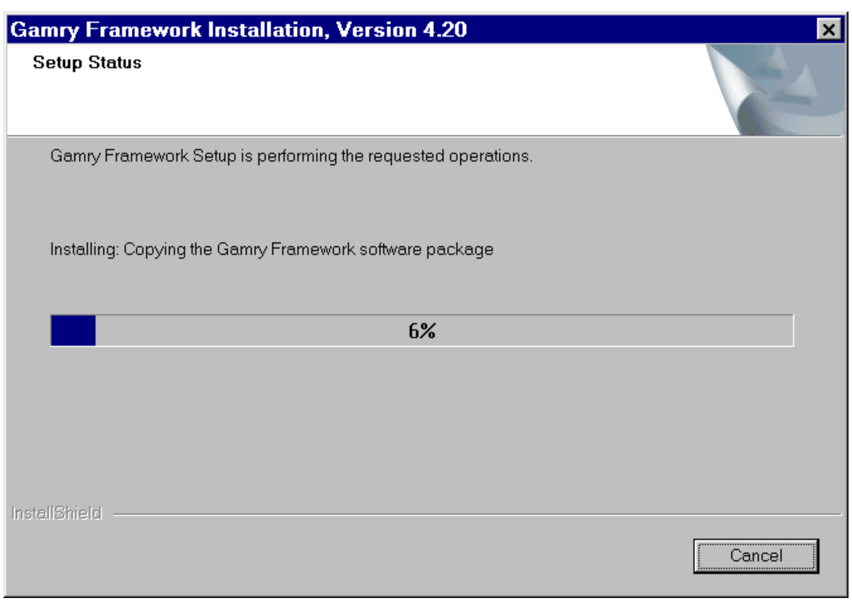
Figure 2-8
Start Copying Files Dialog Box



Select **<u>N</u>ext** to begin the copying of files.

7. A dialog box is displayed while the file copy operation is in progress (see Figure 2-9).

Figure 2-9
Copy Files Status Box



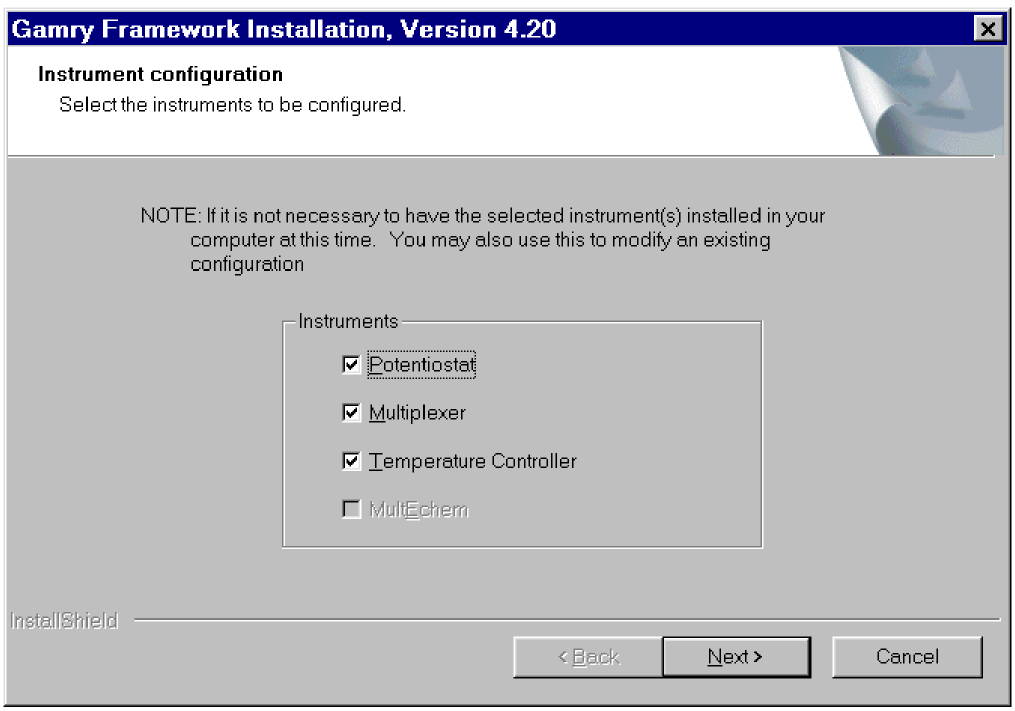
8. Once the file copy operation is complete, hardware configuration begins. Figure 2-10 shows the dialog box used to select the hardware that needs configuration.

   A check preceding an instrument's name indicates that later steps in this procedure will configure that piece of equipment. Add or remove checks to match the requirements of your system. An FC4 or FCI4 Fuel Cell Interface should be selected as a Potentiostat.

   The checkboxes for Potentiostat and MultEchem are mutually exclusive (if one is selected, the other is grayed out). The major difference between these selections is in authorization code entry. If you select Potentiostat, an Authorization Code dialog box appears for each individual potentiostat in the system. If you select MultEchem, only one Authorization Codes dialog box is needed. Checking <u>either</u> box results in a dialog box to name and configure potentiostats.

   Select **Next** once you are satisfied with your instrument selections.

Figure 2-10
Instrument Selection Box



9. If you chose to configure a potentiostat (or fuel cell interface), a dialog box similar to that in Figure 2-11 should appear. This dialog box asks for information regarding the potentiostats in your computer.

   NOTE: Figure 2-11 shows an unusual example – both a PCI4 Family potentiostat and a PC4 family potentiostat are selected in this dialog box. Most systems contain only one potentiostat. Multiple potentiostat systems generally use only devices from one potentiostat family. This unusual example allows us to discuss both PCI4 and PC4 family potentiostat configuration conveniently.

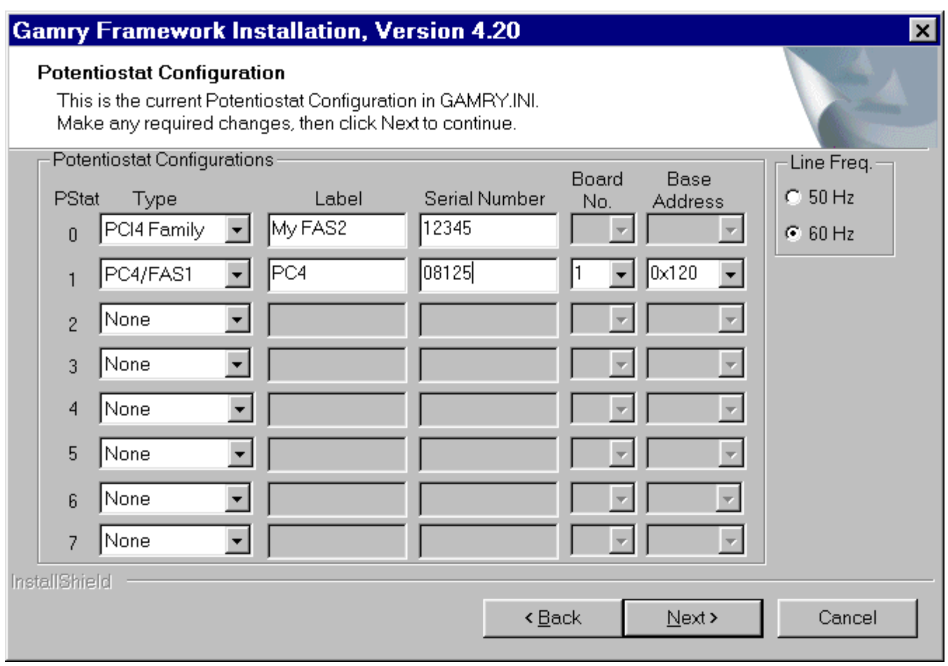
Up to eight different potentiostats may be installed in a computer. Each line in this dialog box is for a different potentiostat. If you have only one potentiostat in your system, you will enter information on the row labeled *Pstat 0*. If you have more than one potentiostat, subsequent information will be entered one or more additional lines *Pstat 1*, *Pstat 2*, and *Pstat 3*.

For each potentiostat you have chosen, information such as Type, Label, and Serial Number must be entered. For PC4 family potentiostats, Board Number and Base Address must also be entered. You cannot enter a Board Number and Base Address for a PCI4 family device.

The potentiostat *Type* reflects the family of the potentiostat.   Two choices (PCI4 Family and PC4/FAS1) are allowed in Revision 4.2 of the Framework.   The PCI4/300, PCI4/750, FAS2, and FCI4 are all in the PCI4 family. The PC4/300, PC4/750, FAS1, and FC4 belong to the PC4/FAS1 family. If no potentiostat is installed yet , *None* will be shown.

Label is text that will be shown whenever the Framework needs to reference the potentiostat. This text is also used in the experimental setup dialog boxes, so you should choose a user-friendly name to enter as the *Label*. This label is limited to 7 characters so that the text can fit in a small selector widget. Labels in a multi-potentiostat system must be unique (we recommend you use a sequence of simple labels such as Pstat1, Pstat2, Pstat3, etc).

Figure 2-11
Potentiostat Configuration Dialog Box



Serial No. is a 5 digit number which definitively identifies the potentiostat. This number is stamped on a label of your potentiostat's Controller Card.   A PCI4 or PC4 potentiostat has two serial numbers – one for the Controller Card and one for the Potentiostat Card. Use the number on the Controller card (the card with the four miniature RF connectors on it).

The Framework matches the *Serial No* entered into Setup with a Serial Number encoded in each PCI4. This allows unambiguous identification of each PCI4 Family device, even if cards are moved within the computer.

Incorrect entry of a PCI4 family serial number will result an error message when you start up the Framework program.

Board No. is the board number setting for a PC4 Family potentiostat. Each Base Address (see below) can hold up to four potentiostats, identified by a board number of 1, 2, 3 or 4. The Board No selected in the setup panel must match the Board Number of the hardware, which is set by DIP-switches on the potentiostat. Consult your Potentiostat's Operators Manual for information regarding setting the potentiostat's Board Number.

The *Base Address* is the address setting for a PC4 Family potentiostat. The base address selected in the setup panel must match the base address of the hardware, which is set by DIP-switches on the potentiostat. Please consult your Potentiostat's Operators Manual for information regarding setting the hardware base address.

A system with multiple PC4 Family potentiostats is generally configured as follows. The first 4 potentiostats in the system all have the same base address and different board numbers. The 5^{th} through 8^{th} potentiostats (if present) share a new base address and once again are differentiated by their board numbers. For example, potentiostats 1 through 4 can use base address 0x120 and 5 through 8 can use base address 0x140.

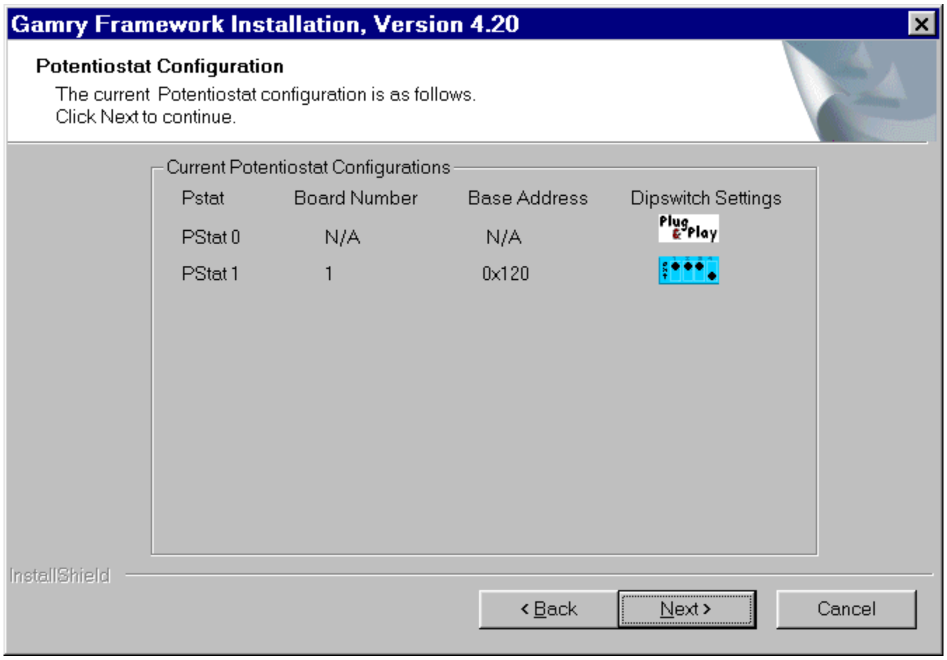
The Windows Device Manager takes care of configuring multiple PCI4 family potentiostats and insuring that each device has a unique address assigned to it. A utility script described in Appendix C of this guide will help you to associate potentiostat *Labels* with potentiostat hardware once the computer system has been closed up.

Line Frequency is the frequency (in Hertz) of the AC power lines to which your equipment will be connected. For applications within the United States, this is 60 Hz. Europe and most of the world outside of the US uses 50 Hz power.

When you have completed entering all of the potentiostat information, click **Next** to continue.

10. To make PC4 Family potentiostat configuration process easier, the Setup program will display the PC4 DIP-switch settings appropriate for the potentiostat configurations chosen in step 9. Figure 2-12 demonstrates this for the potentiostats configured in the Figure 2-11.

Figure 2-12
Potentiostat Switch Settings Box



When examining the switch settings, visualize the PC4 controller board. The gold edge-card connector on the board is pointing toward your body and the components are facing you.

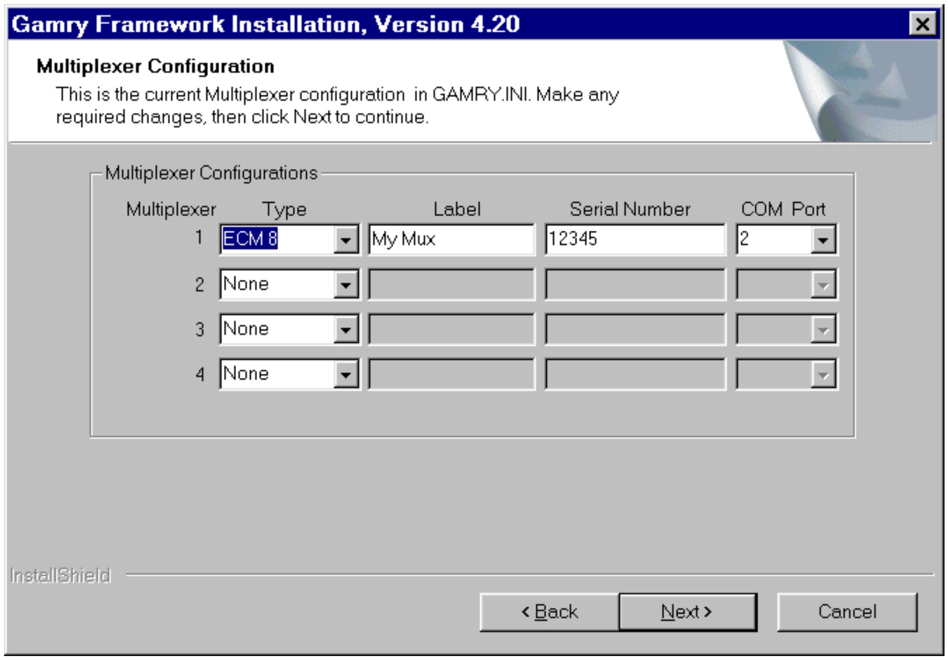
The PC4 Controller Board has only one DIP-switch, located on the right side of the board. The four switches that comprise this DIP-switch should have the pattern in the Potentiostat Switch Settings Dialog Box.

If the DIP-switch settings for your potentiostats are incorrect, we do not recommend that you change the settings during the Framework install process. We do not want you dropping tools into a powered-up computer! Note the correct settings, complete the installation, power down your computer, change the switch settings, then re-power the system. You do not need to reinstall the Framework.

11. If your instrument selection did not include a multiplexer, skip this step.

    Figure 2-13 shows the dialog box used to configure a multiplexer. Gamry's ECM8 is currently the only multiplexer type supported by the Gamry Framework.

Figure 2-13
Multiplexer Configuration Box



Up to four ECM8 multiplexers can be configured using this installation program. For each multiplexer connected to your computer, information such as its type, label, and COM port number need to be entered. Each line in the dialog box is for a different multiplexer. If you have only one multiplexer you will enter information on the line labeled Multiplexer 1.

The multiplexer *Type* reflects the family of the multiplexer, currently only the ECM8. If no multiplexer is installed, *None* will be shown.

The *Label* is a text string that will be shown when the Framework needs to reference the multiplexer. This text is also used in the experimental setup dialog boxes. The Label is limited to seven characters so that the text can fit in a small selector widget. Labels must be unique.

The *Logical Port* is the communications port through which the Framework will communicate with the multiplexer. Many computers have hardware for two COM ports. See Appendix A for more information on COM ports. Select a COM port which is available for each multiplexer.

The *Serial No.* is a 5-digit number which identifies the multiplexer. This number is stamped on the back of the multiplexer.

When you have completed entering all of the multiplexer information, click **Next** to continue.

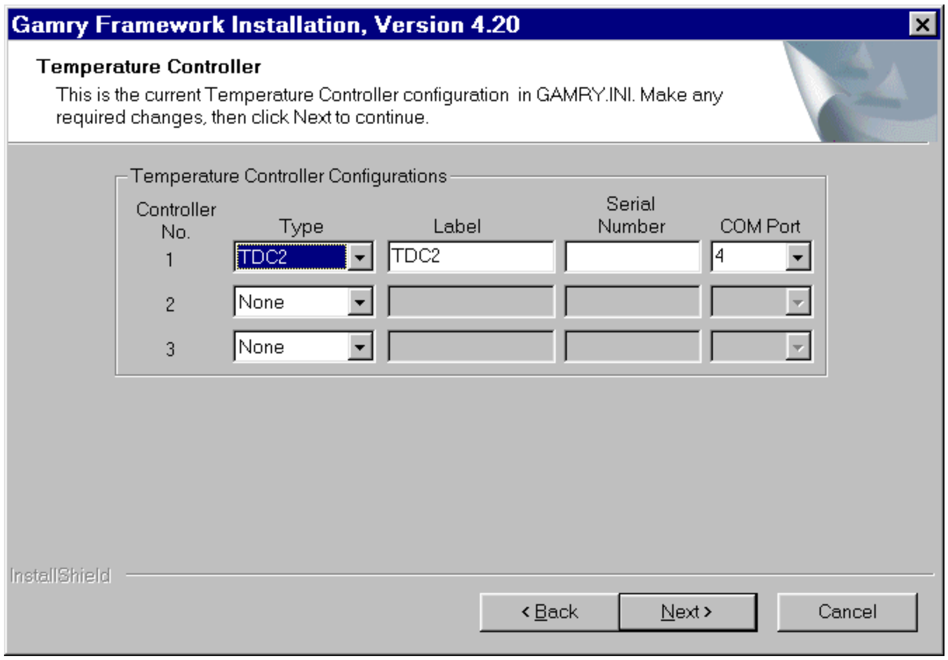
12. If your instrument selection did not include a temperature controller, skip this step.

    Figure 2-14 shows the dialog box used to configure temperature controllers. Up to four temperature controllers can be configured using this dialog box.

    For each temperature controller connected to your computer, information such as its type, label,

and Com port number need to be entered. Each line in the dialog box is for a different controller. If you have only one temperature controller you will enter information on the line labeled Contoller 1. When you have completed entering all of necessary information, click **Next** to continue.

Figure 2-14
Temperature Controller Settings Box



The controller *Type* reflects the family of the temperature controller. Currently, Gamry Instrument's TDC1 and TDC2 controllers are supported as well as Neslab Temperature Baths. If no temperature controller is installed, *None* will be shown.

The *Label* is a text string that will be shown when the Framework needs to reference the temperature controller. This text is also used in the experimental setup dialog boxes. The Label is limited to seven characters so that the text can fit in a small selector widget. The Label text for each temperature controller must be unique.

The *Logical Port* is the communications port through which the Framework will communicate with the temperature controller. Many computers have two COM ports available; however, some newer computers have only one. Select a COM port that is free for each temperature controller.

The *Serial No.* is a 5-digit number which identifies the temperature controller. This number is stamped on the back of the controller.

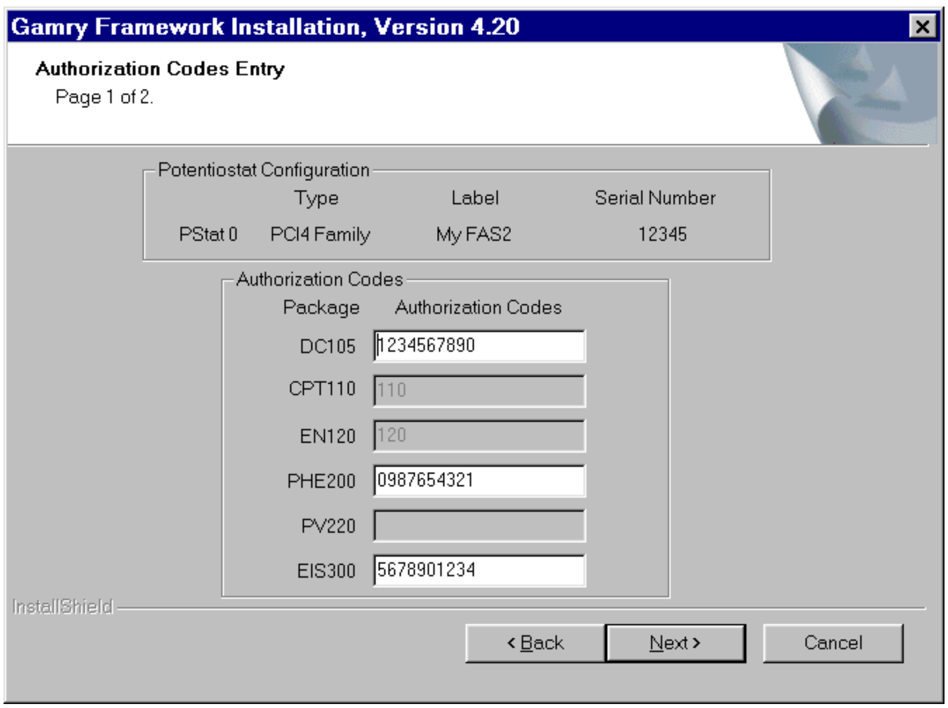
When you have completed entering all of the multiplexer information, click Next to continue.

13. Setup will now display one of more dialog boxes, similar to Figure 2-15, which ask you for the software authorizations codes for a potentiostat or MultEchem system.

    If you selected Potentiostat in the Instrument Selection dialog box (Figure 2-10), each potentiostat in your system gets a separate Authorization Code Dialog Box.

    If you selected MultEchem in the Instrument Selection dialog box only one Authorization Code Dialog Box will appear.

Figure 2-15
Authorization Codes Dialog Box



An authorization code is a unique 10-digit number. Each Gamry Framework application package requires a unique authorization code to run on a specific potentiostat or MultEchem key. You can find these codes on the shipping paperwork for your software. If you have lost the codes, please contact Gamry Instruments.

> NOTE: New authorization codes were issued with Revision 4 of the Gamry Framework. Please do not use authorization codes for previous releases of the software, as they will not work with this and/or later revisions. Contact Gamry Instruments if you are unable to find the authorization codes for your potentiostat(s).

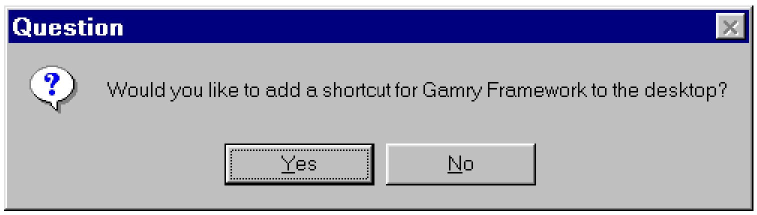
> NOTE: Potentiostats in a MultEchem™ do not have individual authorization codes. Gamry's applications software in a MultEchem system will only run on potentiostats that are associated with a MultEchem USB key.

The Authorization code for a FC350 system is entered in the EIS300 field. The FC350 and the EIS300 can share Authorization codes, since they run on different hardware.

After you have entered the correct authorization code for your potentiostat, select **Next**.

14. Setup will now ask if you want to add a shortcut to the Gamry Framework to your desktop (see Figure 2-16).   In most cases you should answer **Yes**, because this shortcut will make Framework startup simpler and quicker.

Figure 2-16
Add Shortcut Dialog Box



15. Setup will now inform you that the Install Shield Wizard is complete and ask you if you wish to see the Readme text file associated with this Framework installation (see Figure 2-17 and/or Figure 2-18).

    The Readme file contains information too new for this manual. This information may include descriptions of bugs in the software, so we always recommend that you read this file. If you do chose to read the Readme file, it will open up in the Windows Notepad utility when you select **Finish**. When you are done with the file, simply close the Notepad.

    If you are finishing up an initial installation of the Framework software, you will see the dialog box in Figure 2-17. At the end of an initial installation, you normally need to power down your computer, install your potentiostat hardware, and then re-power the computer. Setup is unable to automatically power down the computer – it can merely remind you to power down. The text in Figure 2-17 includes this reminder.

Figure 2-17
Initial Installation – Install Shield Complete

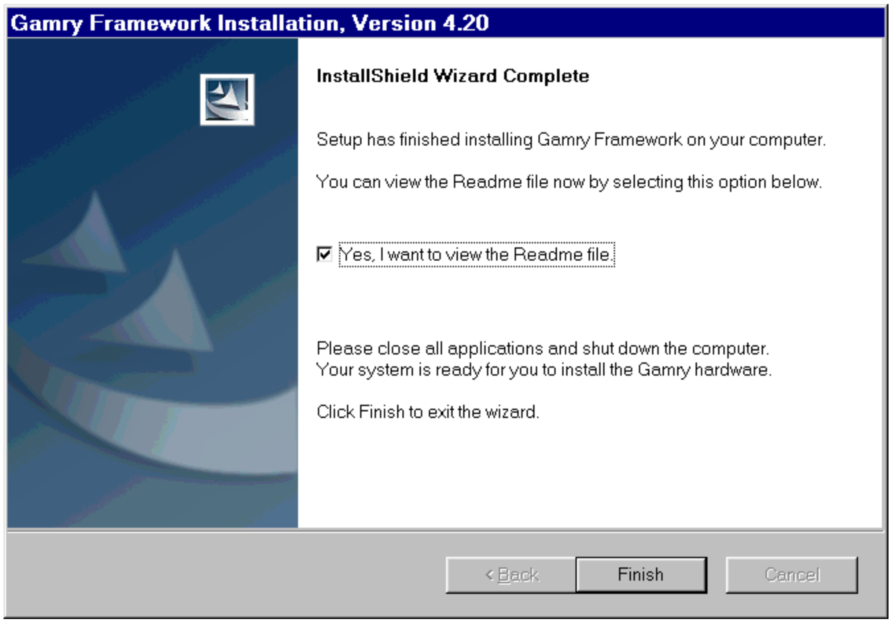
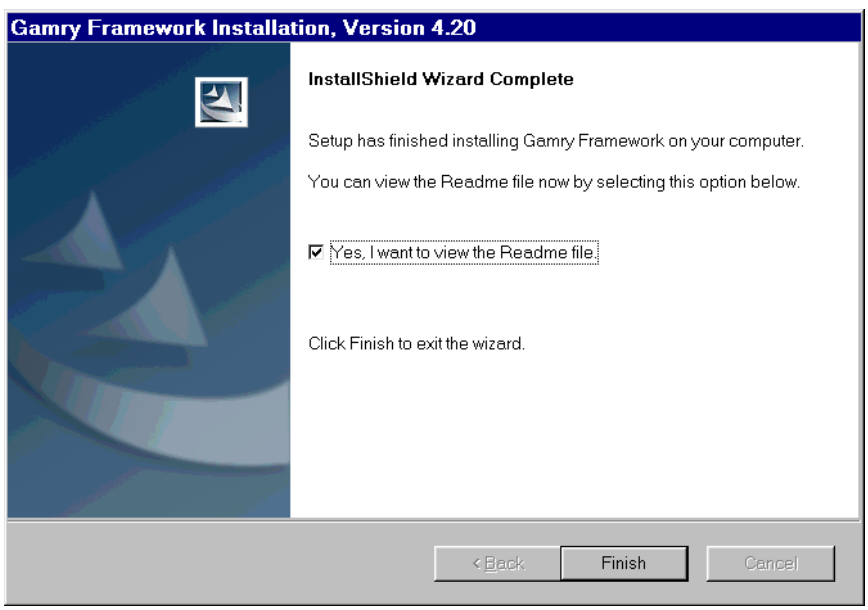


Figure 2-18
Re-install - Install Shield Complete Box



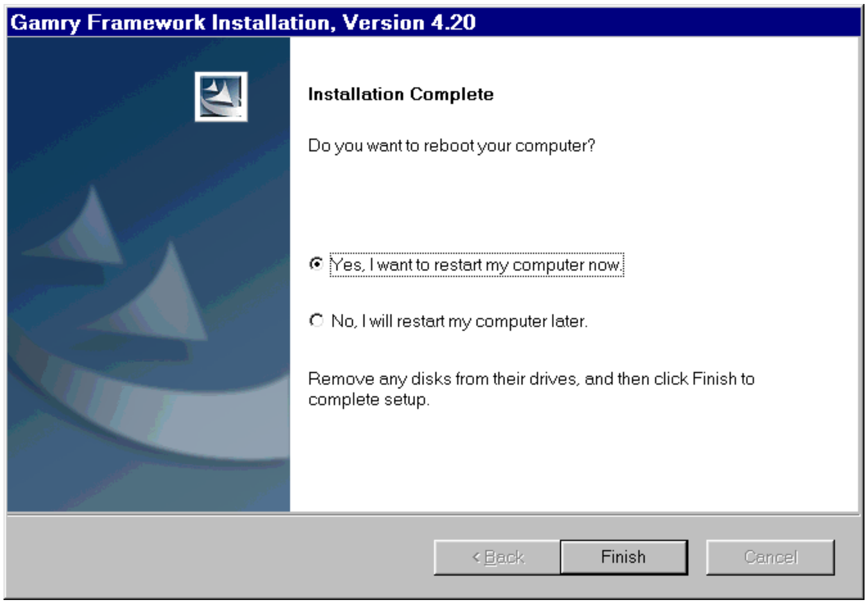
If you are reinstalling the Framework or updating the Framework, you will see the dialog box in Figure 2-18. The reminder to install your hardware has been removed, since we assume that a system with pre-existing software probably has already had its hardware installed.

16. Setup may have one final task. If you are reinstalling or updating the Framework, you want to reboot your computer to finish installing the new drivers.

    The dialog box in Figure 2-19 gives you an opportunity to restart your computer and load the new hardware drivers that came with this software release. We strongly recommend that you reboot your computer by selecting **Finish**.

    Note that Figure 2-19 is only seen for an upgrade or re-installation of the Framework.

Figure 2-19
Installation Complete Box



17. Once the reboot is complete, your system will generally not return to the HTML Setup page.

    If it does not, and you need to setup the Echem analyst, ESA400 or VFP600, you need to restart the HTML Setup page. Simply return to the instructions at the beginning of this chapter, restart the HTML page, and install the additional software.

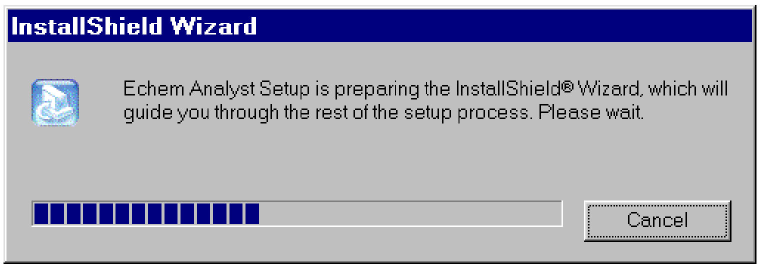
Echem Analyst Setup

The Gamry Echem Analyst is used to plot and perform calculations on electrochemical data acquired using the Gamry Framework. It is generally installed on the computer used to acquired that data, but can also be installed on other computers.

The Echem Analyst Setup is generally started by clicking on its link in the HTML Setup page that is provided with the Gamry Software Distribution CD.

The first item that appears on the screen during the Framework Setup process is a message box (see Figure 2-20).

Figure 2-20
Install Shield Wizard Loading



After a few seconds, the display switch to a red background with a white message in the upper-left corner of the screen. This message should read:

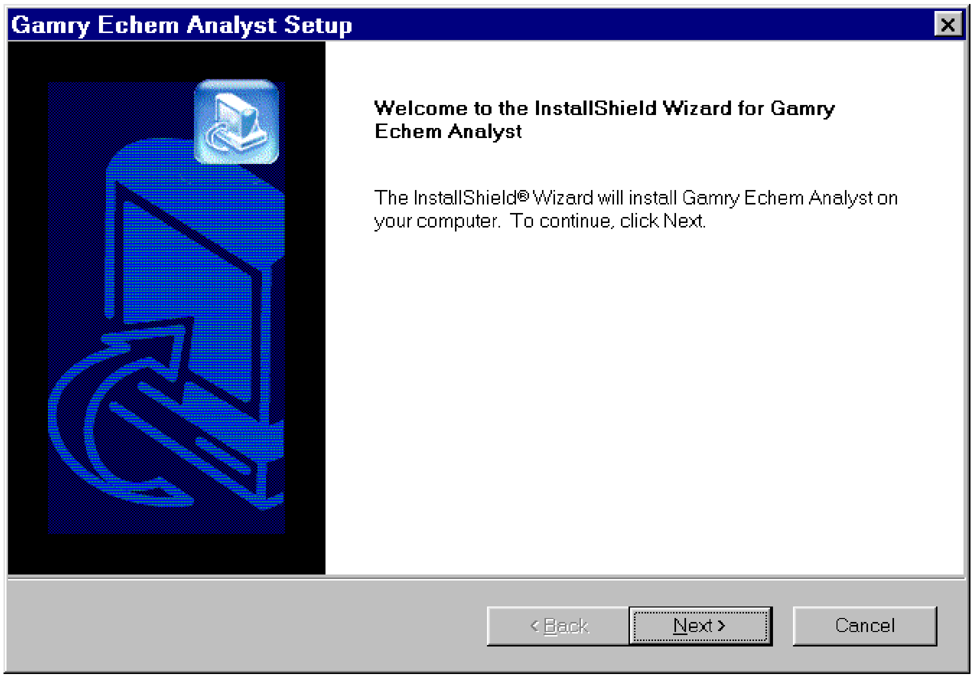
Gamry Echem Analyst

The red background and message will remain on the screen as this sequence of events occur:

1. The Welcome dialog box in Figure 2-21 will appear on top of the red background.

   This dialog box is the usual starting point for a Echem Analyst Installation. It is used to tell you what process is about to occur, and to give you a change to cancel that process.   Press **Next**.

Figure 2-21
Welcome Dialog Box

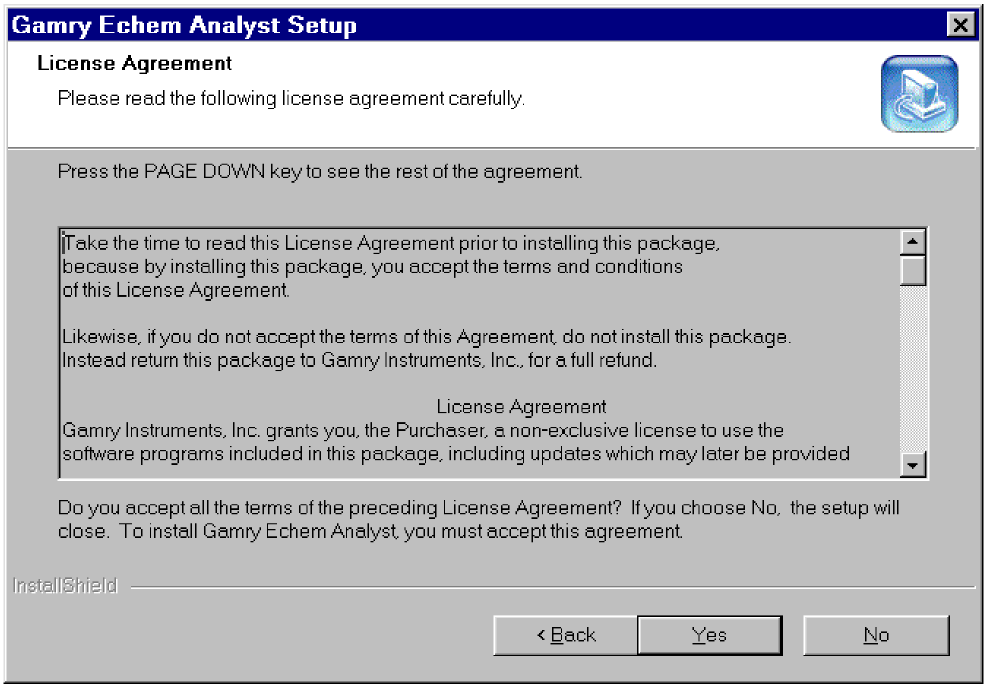


2. The next dialog box is Gamry Software license box (Figure 2-22). You must read the license statement in the text box and select **Yes** before you can install the Echem Analyst software.

   Selecting **Yes** commits you to obey the legal restrictions in the license agreement. The provisions in the Gamry Echem Analyst license agreement are standard terms generally found in commercial software licenses.

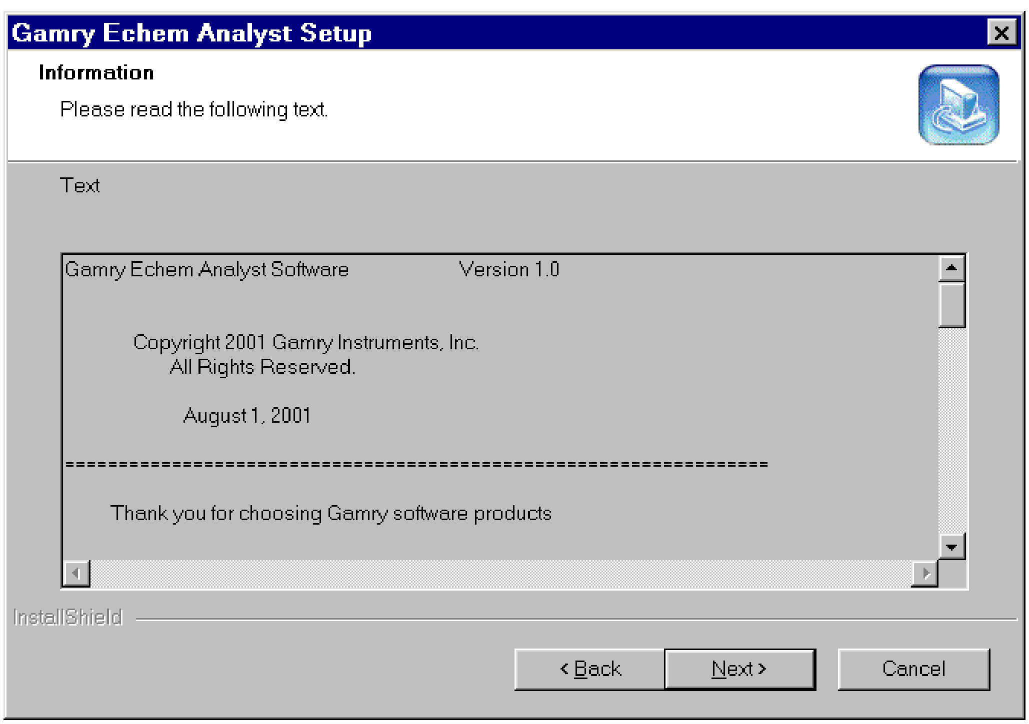
   If you disagree with any of the licensing provisions, you can select **No** in Gamry License dialog box and chose to not install the software. Once you do so, you can return the software for a full refund.

Figure 2-22
Gamry Echem Analyst License Dialog Box



3. Once you have accepted the Analyst License, you will be asked to read a Readme file. See Figure 2-23.

Figure 2-23
Echem Analyst Information (Readme) Dialog Box

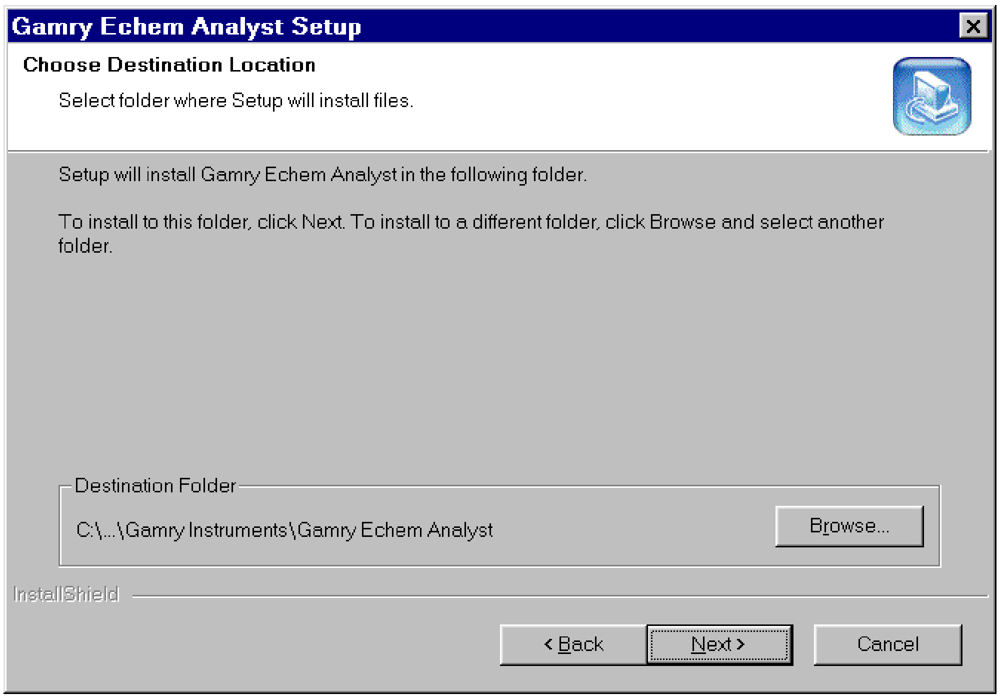


This Readme file contains the latest information about the Echem Analyst, including unfixed bugs in the program (if any).

Select **Next** after reading the information.

4. You will now be asked to choose a destination directory for the installation of the Echem Analyst files (Figure 2-24).

Figure 2-24
Gamry Echem Analyst Destination Box



Data files, script files, and analysis programs all install in sub-directories of the disk directory chosen in this step.

We strongly recommend that you install into the default directory by selecting **Next**. Technical support for your system is much simpler if you use the default directory. Of course, we have tested the system for proper operation in other directories.

Alternate directories can only be chosen via the **Browse** function. This opens up a standard Windows File Selection Dialog Box, which will not be described here. Once you have selected a new destination directory, press **Next** to continue the installation process.

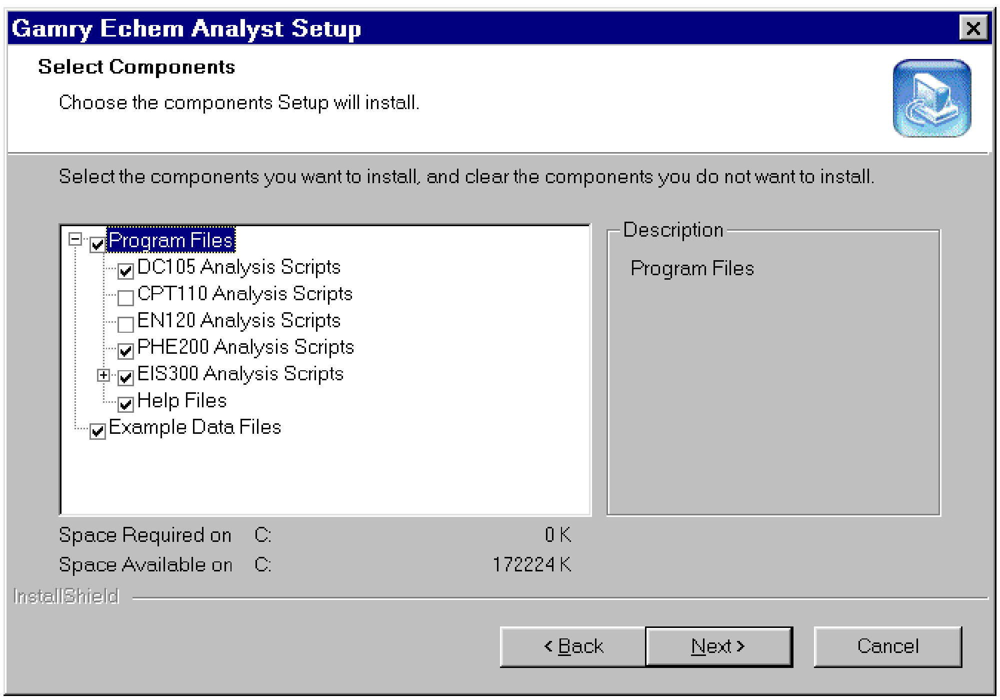
5. The next dialog box is seen in Figure 2-25. This dialog box allows you to select specific Analyst applications for installation. The scripts are organized under the Framework application that generates the data.

   Installation of an analyst application takes up hard disk space on your computer, so you might only want to install applications that you will use.

   The selection of Analyst applications is made in a tree-like selector. Analyst applications shown with a check in their checkbox will be installed. Clicking the mouse on a checkbox toggles the state of that checkbox.

   The dialog box shown in Figure 2-25 has already been modified. The checkboxes for the CPT110 and the EN120 have been deselected.

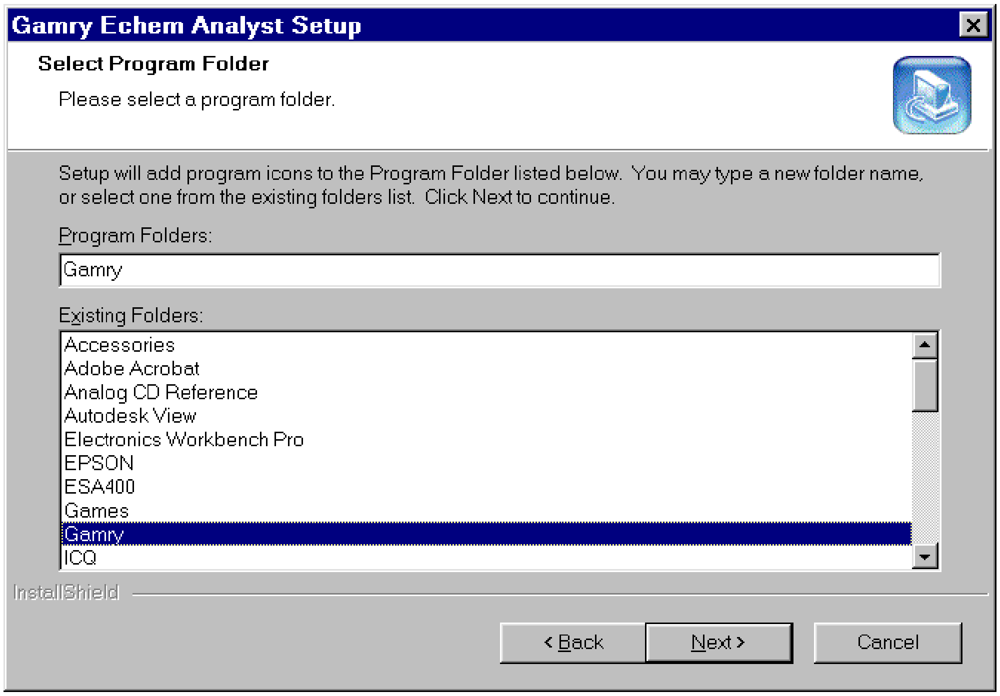
Figure 2-25
Echem Analyst Application Selection Box



6. The next dialog box asks you for the name of a folder than will contain the icon for the Echem Analyst. This is different than the folder used to hold the files. See Figure 2-26.

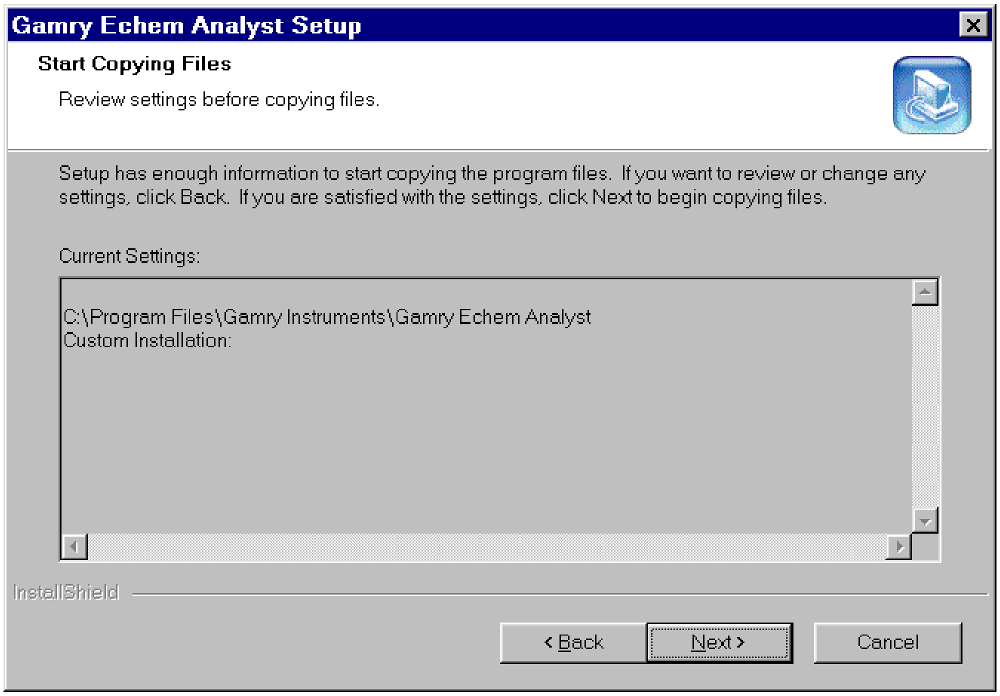
   If you are uncertain what to do at this step, simply select Gamry as the folder and select **Next**.

Figure 2-26
Echem Analyst Application Selection Box



7. The next dialog box (see Figure 2-27) lists your installation choices and asks you to confirm them prior to transferring files to your computer's hard drive.

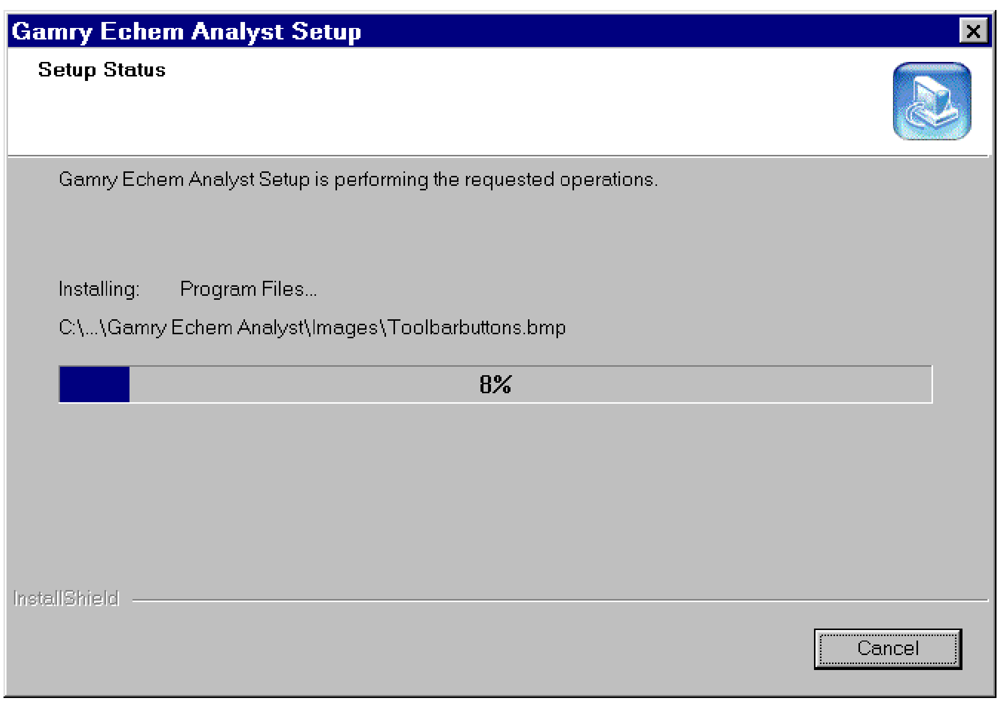
Figure 2-27
Start Copying Files Dialog Box



Select **Next** to begin the copying of files.

8. A dialog box is displayed while the file copy operation is in progress (see Figure 2-28).

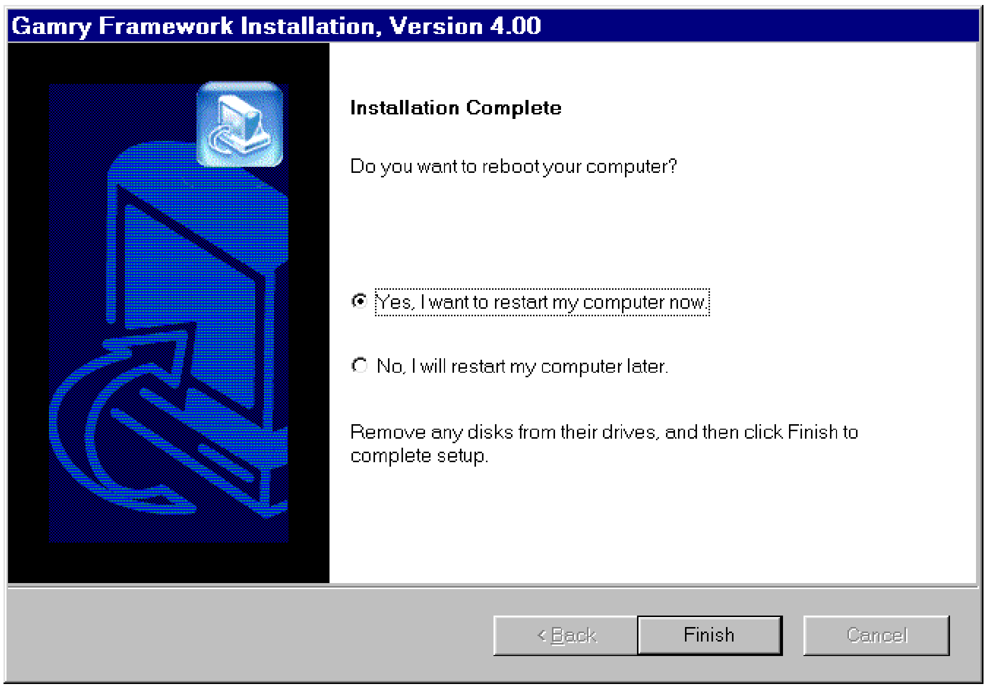
Figure 2-28
Copy Files Status Box



9. Setup has one final task. The VBA installation is not complete until your computer is rebooted (see the dialog box in Figure 2-29).

   We strongly recommend that you reboot your computer by selecting **Finish**. The Echem Analyst may not load properly if you wait before rebooting.

Figure 2-29
Installation Complete Box



10. Once the reboot is complete, your system may or may not return to the HTML Setup page.

    If it does not, and you need to setup the Echem analyst, ESA400 or VFP600, you need to restart the HTML Setup page. Simply return to the instructions at the beginning of this chapter, restart the HTML page, and install the additional software.

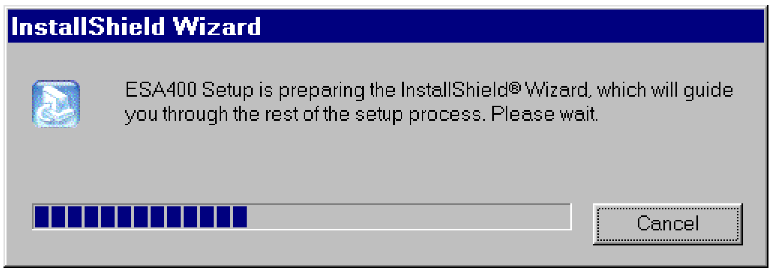
ESA400 Electrochemical Signal Analyzer Setup

The ESA400 Setup should be started by clicking on its link in the HTML Setup page that is provided with the Gamry Software Distribution CD.

Remember that you must install the Gamry Framework before you load the ESA400.

The first item that appears on the screen during the Framework Setup process is a message box (see Figure 2-30).

Figure 2-30
Install Shield Wizard Loading



After a few seconds, the display switch to a blue background with a white message in the upper-left corner of the screen. This message should read:

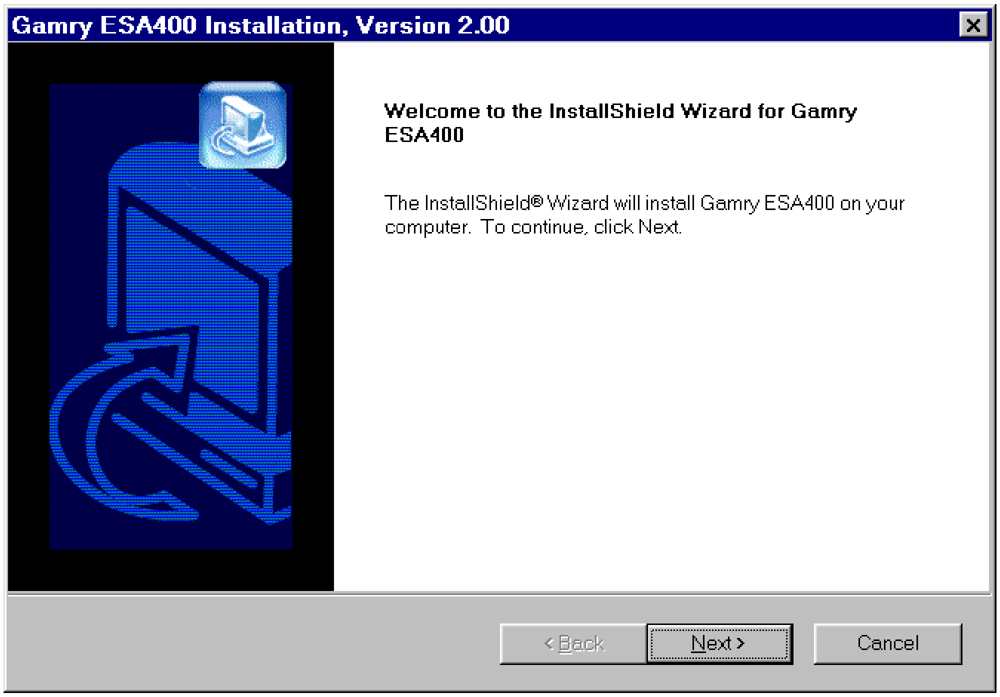
Installing ESA400
Revision 2.0
For Windows® 98/ME/2000

The blue background and message will remain on the screen as the following sequence of events occur:

1. The Welcome dialog box in Figure 2-31 will appear on top of the blue background.

   This dialog box is the usual starting point for an ESA400 Installation. It is used to tell you what process is about to occur, and to give you a change to cancel that process. Press **Next**.

Figure 2-31
Welcome Screen for the ESA400 Install Wizard



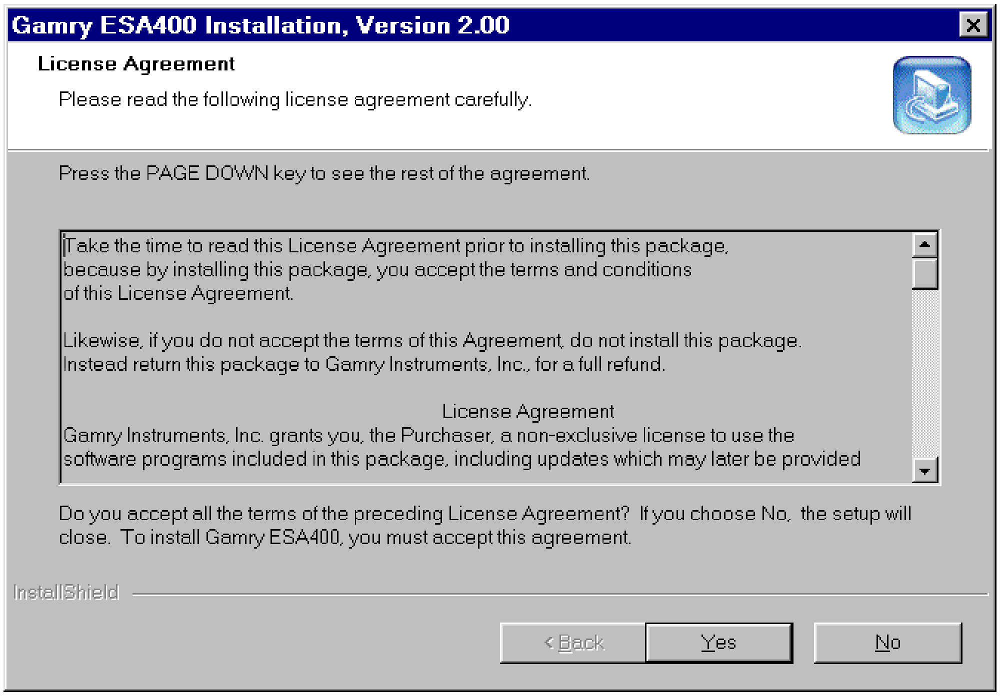
Select **Next** to begin the installation process.

2. The next dialog box is Gamry Software license box (Figure 2-32). You must read the license statement in the text box and select **Yes** before you can install the ESA400 software.

   Selecting **Yes** commits you to obey the legal restrictions in the license agreement. The provisions in the Gamry ESA400 license agreement are standard terms generally found in commercial software licenses.

   If you disagree with any of the licensing provisions, you can select **No** in Gamry License dialog box and chose to not install the software. Once you do so, you can return the software for a full refund.

Figure 2-32
ESA400 License Dialog Box



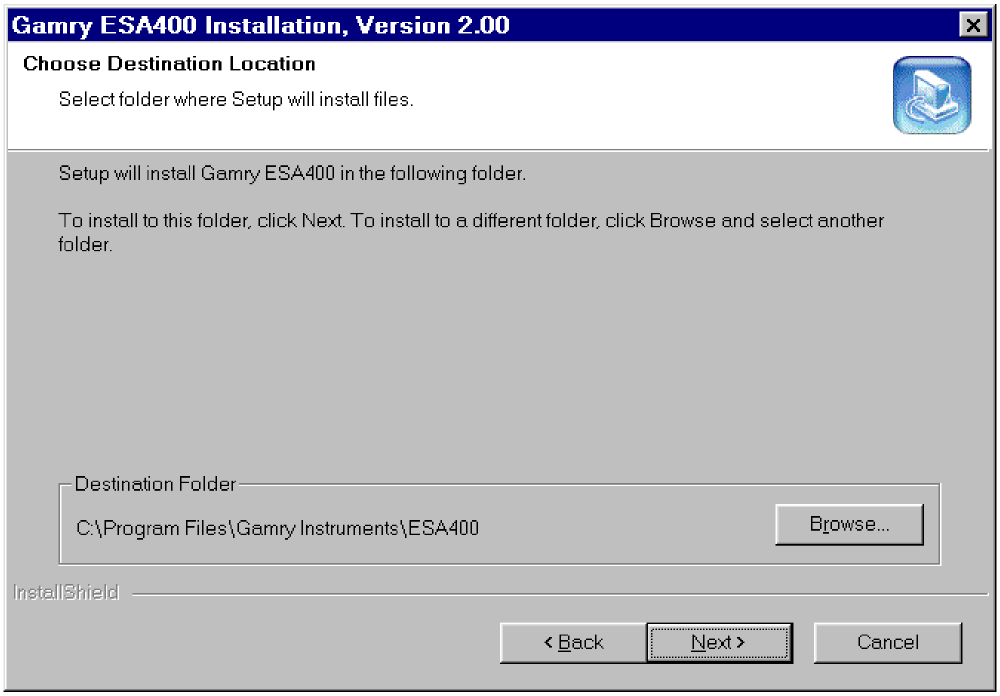
3. You will now be asked to choose a destination directory for the installation of the ESA400 files (Figure 2-33).

   Program files and data files programs all install in sub-directories of the disk directory chosen in this step.

   We strongly recommend that you install into the default directory by selecting **Next**. Technical support for your system is much simpler if you use the default directory. Of course, we have tested the system for proper operation in other directories.

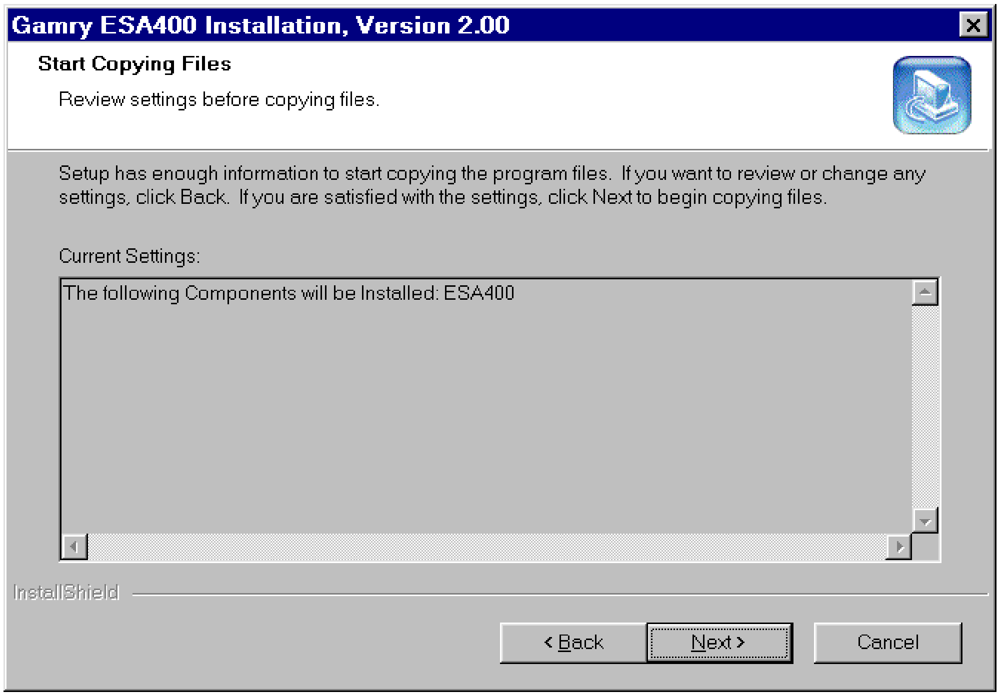
   Alternate directories can only be chosen via the **Browse** function. This opens up a standard Windows File Selection Dialog Box, which will not be described here. Once you have selected a new destination directory, press **Next** to continue the installation process.

Figure 2-33
Gamry ESA400 Destination Box



4. The next dialog box (see Figure 2-34) lists your installation choices and asks you to confirm them prior to transferring files to your computer's hard drive.

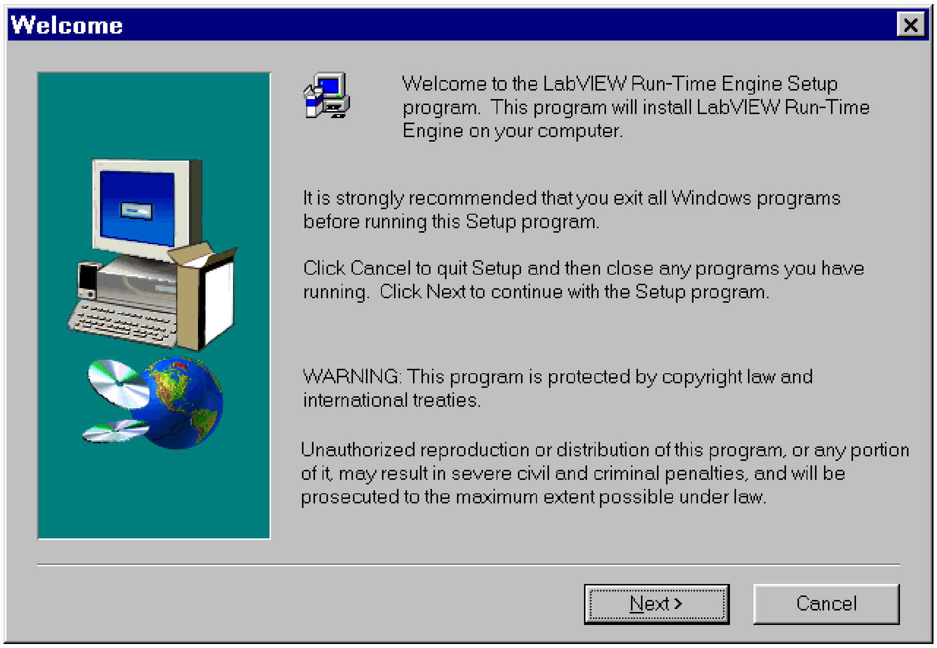
Figure 2-34
Start Copying Files Dialog Box



Select **Next** to continue the installation process.

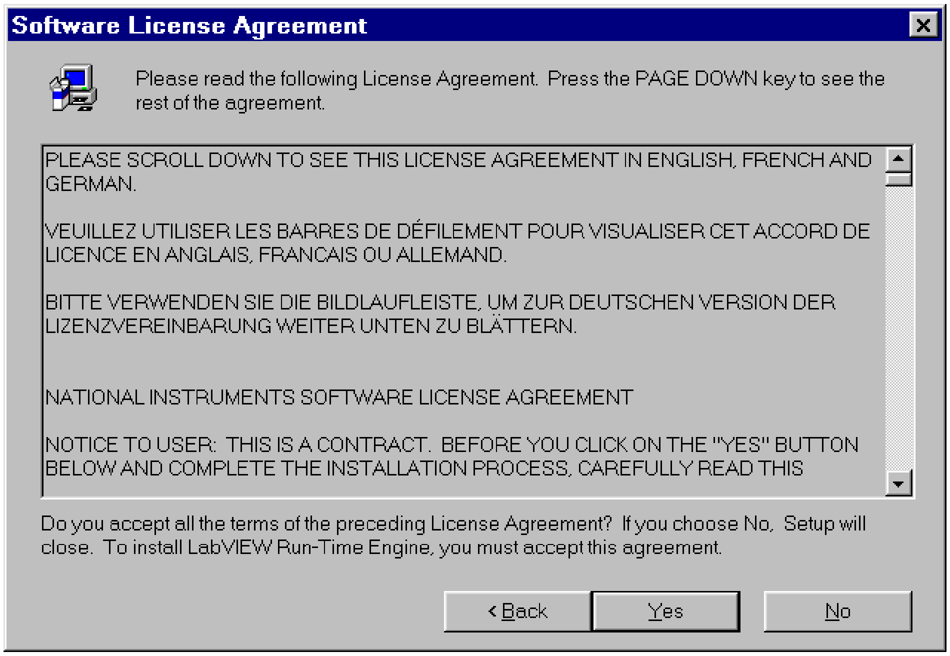
5. Setup will now start a Sub-setup of the LabView Run-Time engine, shown in Figure 2-35. Components of the ESA400 have been written in LabView, and therefore require that the LabView Run-Time Engine be installed.

Figure 2-35
Welcome Screen for the Run-Time Engine Install Wizard



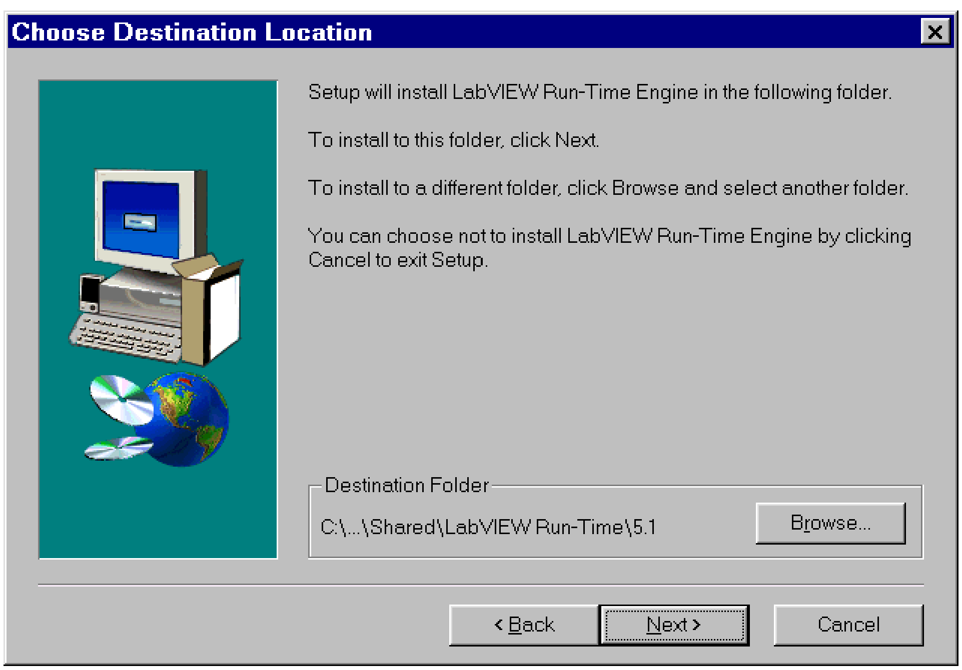
6. Select **Next** to continue the installation of the Run-Time Engine.
7. The Run-Time Engine setup will now present a License Agreement shown in Figure 2-36. Click on **Yes** if you agree to the conditions.

Figure 2-36
License Screen for the LabView Run-Time Engine



8. Setup will now ask for the location to install the Run-Time engine as shown in Figure 2-37. You should use the default location if possible. Click **Next** to continue.

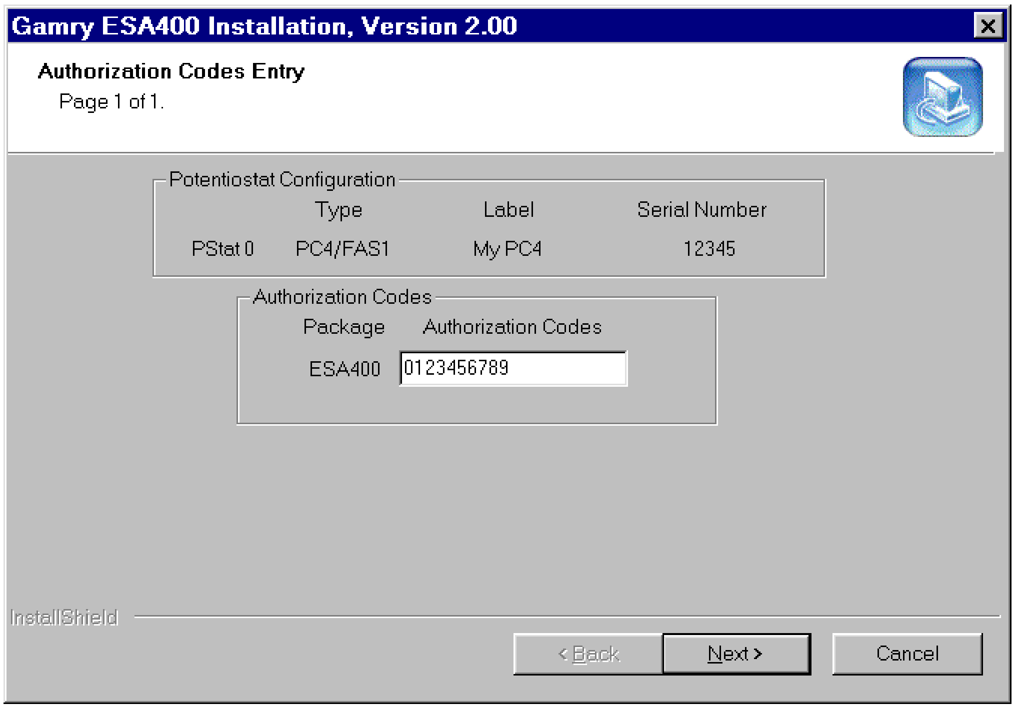
Figure 2-37
Destination Dialog Box for the Run-Time Engine



9. Setup will now copy files to your hard drive (if requested). If at any time you need to stop the copy process, click the **Cancel** button or press **ESC**.

10. Setup will now display one of more dialog boxes, similar to Figure 2-38, which ask you for the ESA software authorizations code for a potentiostat. Each potentiostat in your system gets a separate Authorization Code Dialog Box and requires a specific code.

Figure 2-38
Authorization Codes Dialog Box



An authorization code is a unique 10-digit number. The ESA400 checks this authorization code before it runs on a specific potentiostat. You can find these codes on the shipping paperwork for your system. If you have lost the codes, contact Gamry Instruments.

NOTE: New authorization codes were issued with Revision 2 of the Gamry ESA400. Do not use authorization codes for previous releases of the software, as they will not work with this and/or later revisions. Contact Gamry Instruments if you are unable to find the authorization codes for your potentiostat(s).

After you have entered the correct authorization code for your potentiostat, select **Next**.

11. After the copy process is complete, Setup will inquire whether you would like a shortcut (icon) to the ESA400 placed on the Desktop. If you do not wish to have a shortcut placed on the desktop, select **No**. Otherwise, select **Yes**.

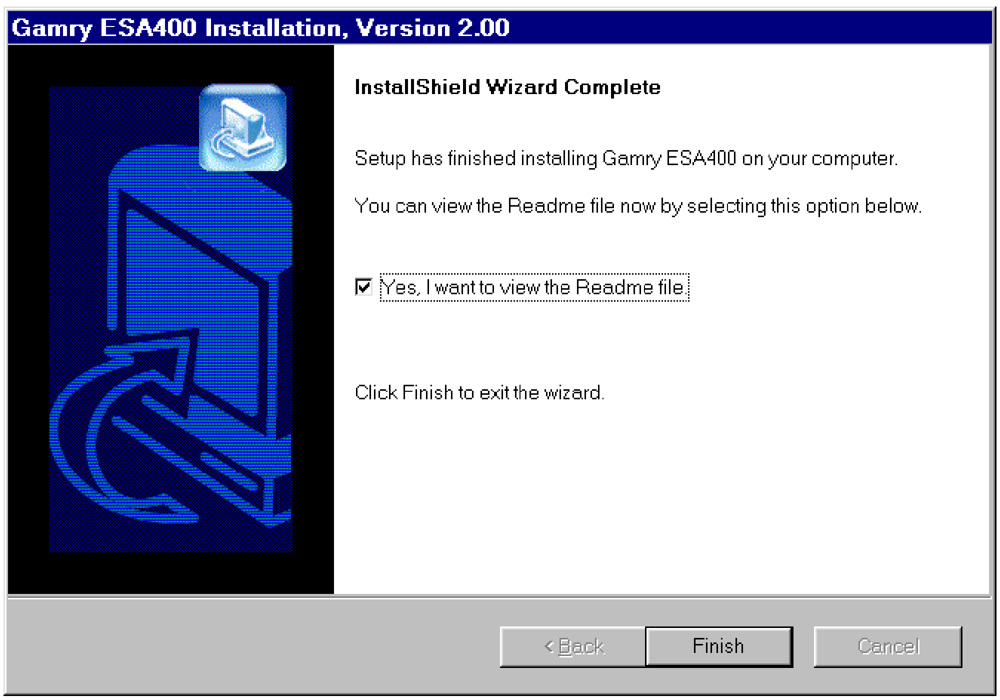
12. Setup will now inform you that the installation is complete and ask you if you wish to see the Readme text file associated with this ESA400 installation (see Figure 2-39).

    Select **Finish** to proceed to the final step in the installation.

    The Readme file contains information too new for this manual. This information may include descriptions of bugs in the software, so we always recommend that you read the Readme file.

    If you do chose to read the Readme file, it will open up in the Windows Notepad utility. When you are done with the file, simply close the Notepad.

Figure 2-39
Install Shield Complete Box



Your system should now return to the HTML Setup page.

VFP600 Virtual Front Panel Setup

The VFP600 Setup is generally started by clicking on its link in the HTML Setup page that is provided with the Gamry Software Distribution CD.

Remember that you must install the Gamry Framework before you load the VFP600.

A few seconds after clicking on the link, the display will switch to a blue background with a white message in the upper-left corner of the screen. This message should read:

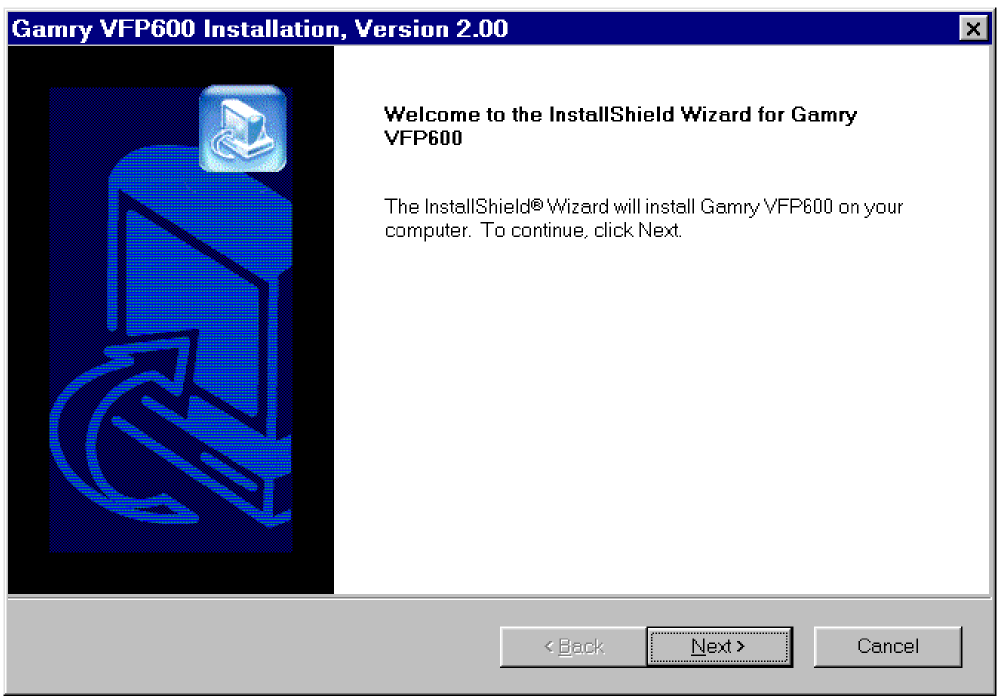
> Installing VFP600
> Revision 2.0
> For Windows® 98/ME/2000

The blue background and message will remain on the screen as the following sequence of events occur:

1. The Welcome dialog box in Figure 2-40 will appear on top of the blue background.

   This dialog box is the usual starting point for an VFP600 Installation. It is used to tell you what process is about to occur, and to give you a change to cancel that process. Press **Next**.

Figure 2-40
Welcome Screen for theVFP600 Install Wizard



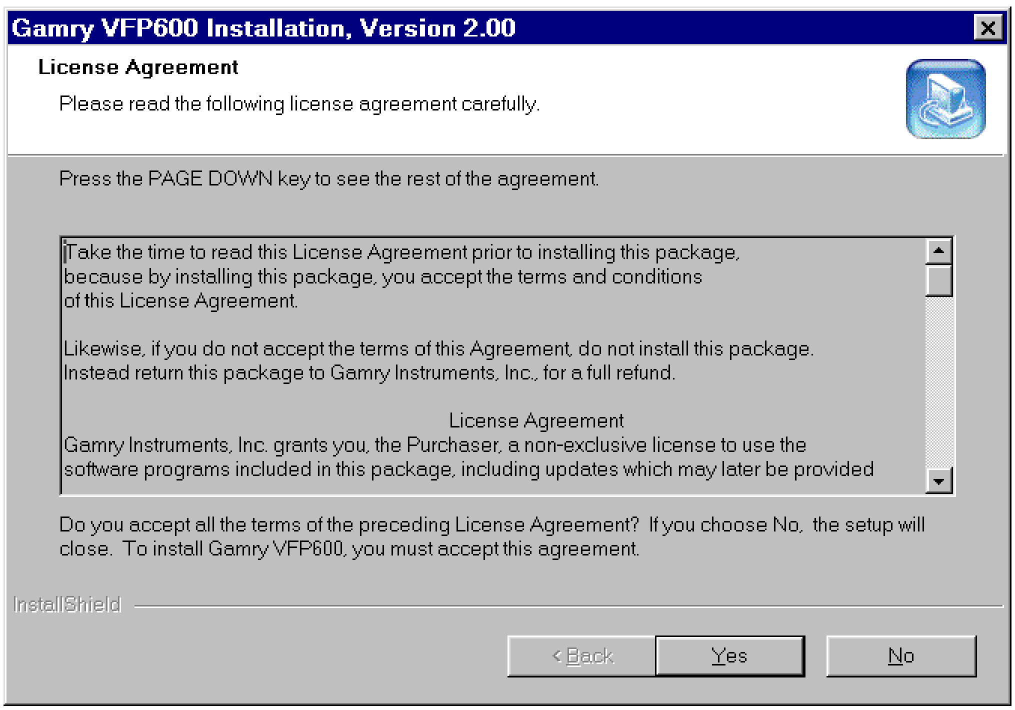
Select **Next** to begin the installation process.

2. The next dialog box is Gamry Software license box (Figure 2-41). You must read the license statement in the text box and select **Yes** before you can install the VFP600 software.

   Selecting **Yes** commits you to obey the legal restrictions in the license agreement. The provisions in the Gamry VFP600 license agreement are standard terms generally found in commercial software licenses.

   If you disagree with any of the licensing provisions, you can select **No** in Gamry License dialog box and chose to not install the software. Once you do so, you can return the software for a full refund.

Figure 2-41
VFP600 License Dialog Box



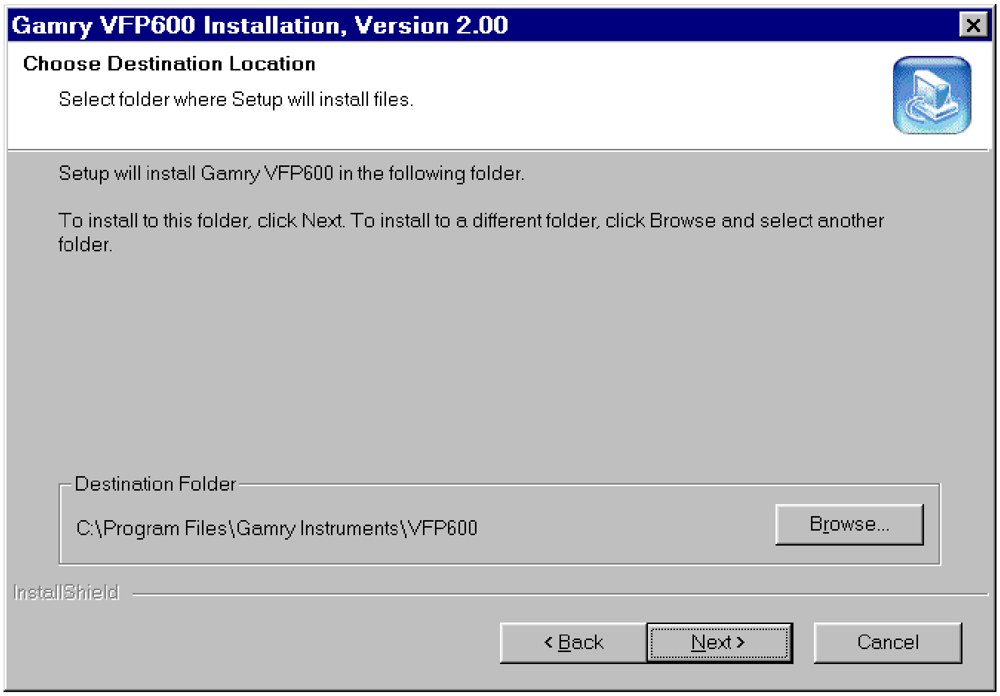
3. You will now be asked to choose a destination directory for the installation of the VFP600 files (see Figure 2-42).

   Program files and data files programs all install in sub-directories of the disk directory chosen in this step.

   We strongly recommend that you install into the default directory by selecting **Next**. Technical support for your system is much simpler if you use the default directory. Of course, we have tested the system for proper operation in other directories.

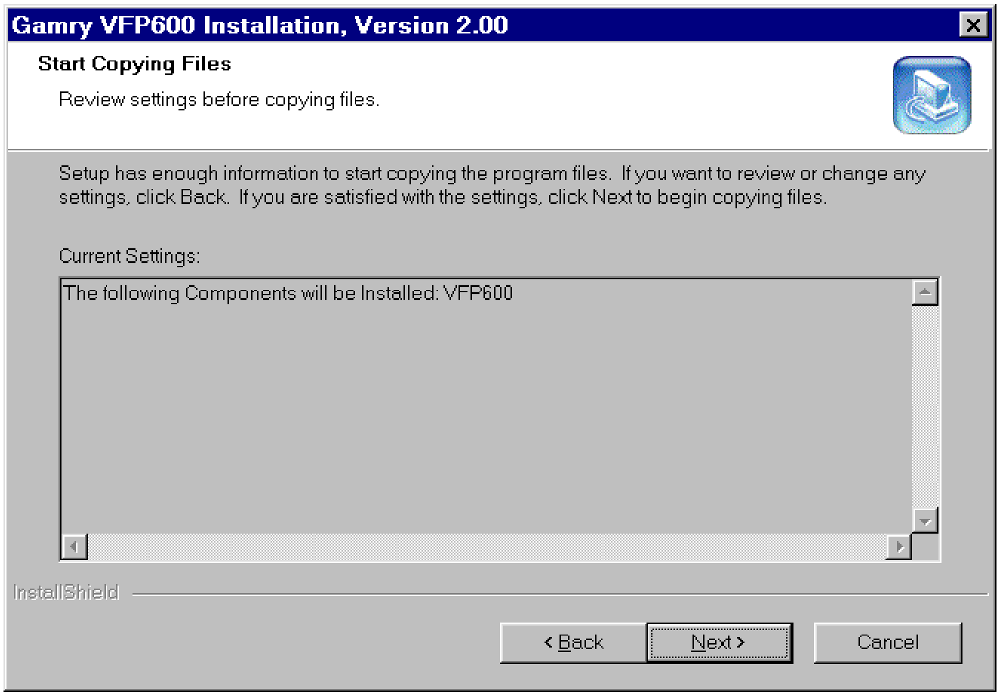
   Alternate directories can only be chosen via the **Browse** function. This opens up a standard Windows File Selection Dialog Box, which will not be described here. Once you have selected a new destination directory, press **Next** to continue the installation process.

Figure 2-42
Gamry VFP600 Destination Box



4. The next dialog box (see Figure 2-43) lists your installation choices and asks you to confirm them prior to transferring files to your computer's hard drive.

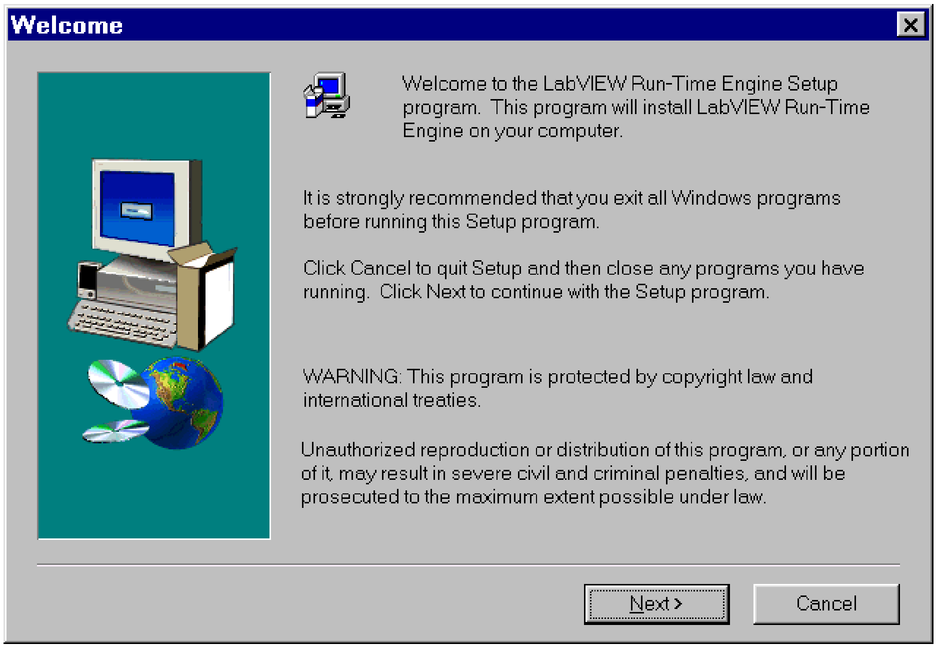
Figure 2-43
Start Copying Files Dialog Box



Select **Next** to continue the installation process.

5. Setup will now start a Sub-setup of the LabView Run-Time engine, shown in Figure 2-44. Components of the VFP600 have been written in LabView, and therefore require that the LabView Run-Time Engine be installed.

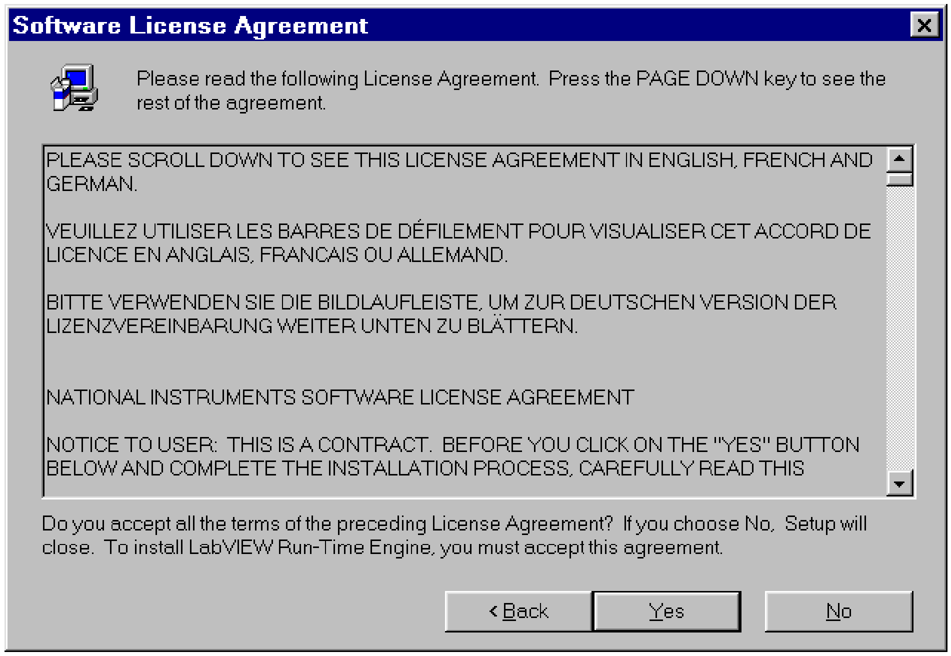
Figure 2-44
Welcome Screen for the Run-Time Engine Install Wizard



6. Select **Next** to continue the installation of the Run-Time Engine.

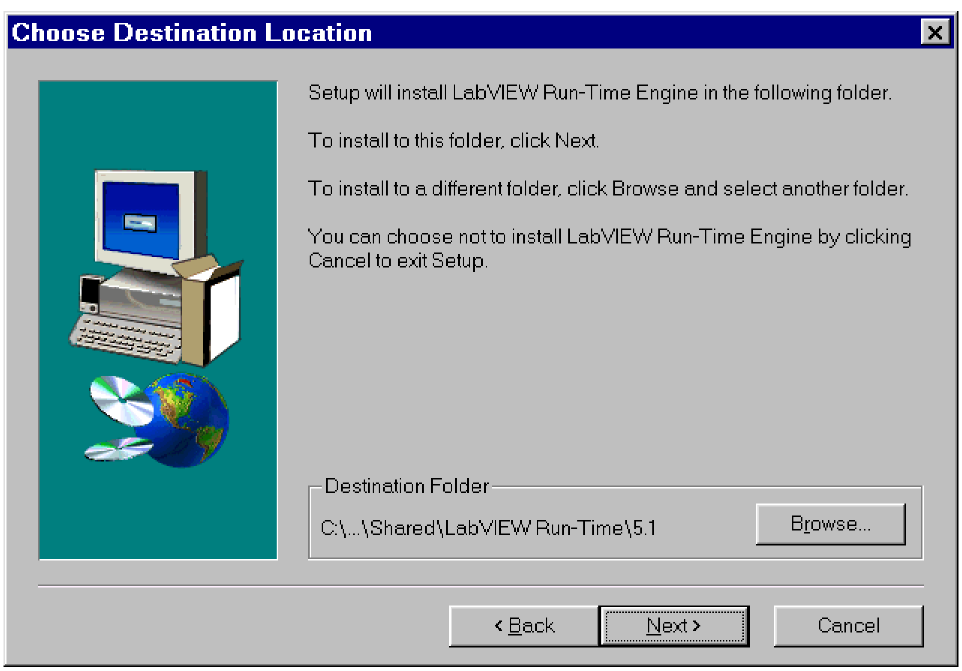
7. The Run-Time Engine setup will now present a License Agreement shown in Figure 2-45. Click on **Yes** if you agree to the conditions.

Figure 2-45
License Screen for the LabView Run-Time Engine



8. Setup will now ask for the location to install the Run-Time engine as shown in Figure 2-46. You should use the default location if possible. Click **Next** to continue.

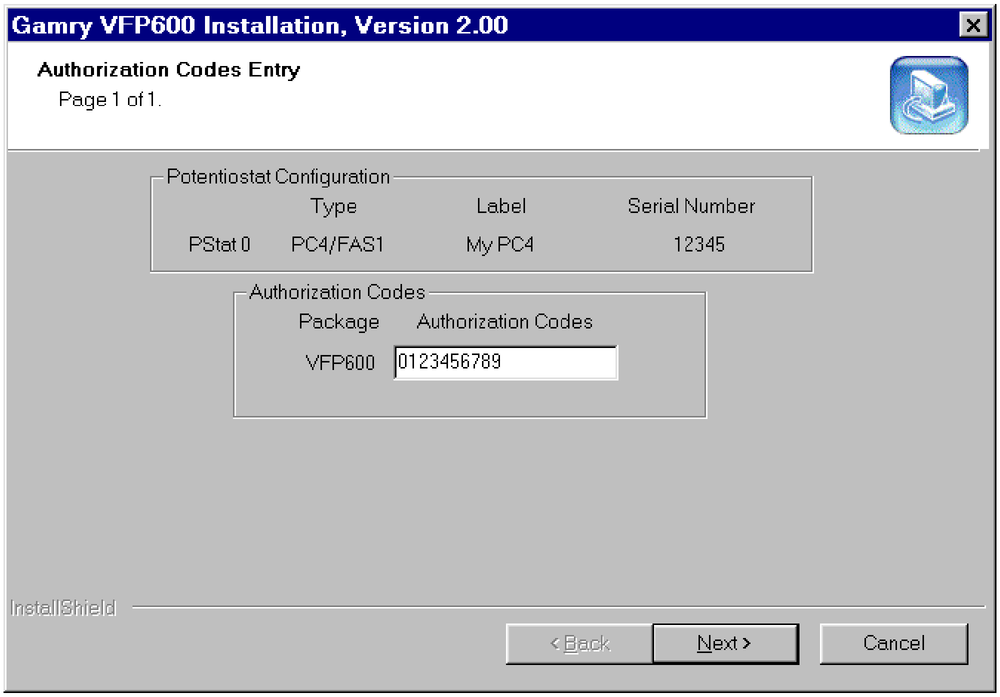
Figure 2-46
Destination Dialog Box for the Run-Time Engine



9. Setup will now copy files to your hard drive (if requested). If at any time you need to stop the copy process, click the **Cancel** button or press **ESC**.

10. Setup will now display one of more dialog boxes, similar to Figure 2-47, which ask you for the VFP600 software authorizations code for a potentiostat. Each potentiostat in your system gets a separate Authorization Code Dialog Box and requires a specific code.

Figure 2-47
Authorization Codes Dialog Box



An authorization code is a unique 10-digit number. The VFP600 requires a unique authorization code to run on a specific potentiostat. You can find these codes on the shipping paperwork for your system. If you have lost the codes, please contact Gamry Instruments.

> NOTE: New authorization codes were issued with Revision 2 of the Gamry VFP600. Please do not use authorization codes for previous releases of the software, as they will not work with this and/or later revisions. Contact Gamry Instruments if you are unable to find the authorization codes for your potentiostat(s).

After you have entered the correct authorization code for your potentiostat, select **Next**.

11. After the copy process is complete, Setup will inquire whether you would like a shortcut (icon) to the VFP600 placed on the Desktop. If you do not wish to have a shortcut placed on the desktop, select **No**. Otherwise, select **Yes**.

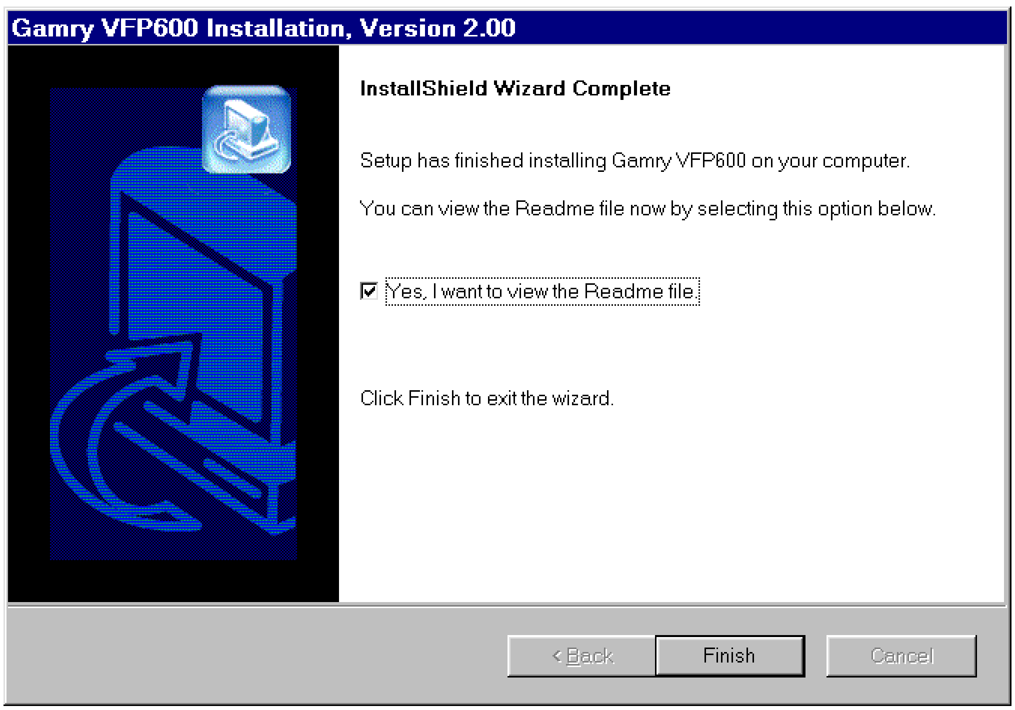
12. Setup will now inform you that the installation is complete and ask you if you wish to see the Readme text file associated with this VFP600 installation (see Figure 2-48).

    Select **Finish** to proceed to the final step in the installation.

    The Readme file contains information too new for this manual. This information may include descriptions of bugs in the software, so we always recommend that you read the Readme file.

    If you do chose to read the Readme file, it will open up in the Windows Notepad utility. When you are done with the file, simply close the Notepad.

Figure 2-48
Install Shield Complete Box



Your system should now return to the HTML Setup page.

Chapter 3 – Software Descriptions

General Description

Gamry's software can be divided into three overall groups.

The first group is the Gamry Framework and its applications: The DC105, CPT110, EN120, PHE200, PV220, and EIS300 all use the Gamry Framework for data acquisition and experiment control and use the Gamry EChem Analyst for data analysis. Data acquisition requires a Gamry Instruments potentiostat in the computer.

The second group includes the ESA400 and the VFP600. They are self-contained compiled applications written in National Instrument's Labview. These applications only use the Gamry Framework for calibration and do not use the EChem Analyst at all. They also require a Gamry Instruments potentiostat.

The software from either of these first two groups supports a variety of Gamry Instruments' potentiostats. These include the PCI4 family potentiostats (PCI4/300, PCI4/750, or FAS2) or the PC4 Family potentiostats (PC4/300, PC4/750 or FAS1). Revision 4.2 of these applications will not work with PC3 family potentiostats or the FC4 or FCI4 Fuel Cell Interfaces.

The FC350 is a unique product. It uses the Gamry Framework and the EChem Analyst because its development started with the EIS300 software. However, it cannot be used with any standard Potentiostat/Galvanostat/ZRA. Instead it uses FC4 or FCI4 Fuel Cell Interface connected to a programmable power supply or electronic load that controls a fuel cell or battery.

Gamry Framework Product Description

The Gamry Framework is the foundation for most Gamry Instruments Windows-based software. The Gamry Framework is the program that runs when you select Framework from the Windows Start Menu.

Framework makes a menu structure, editing tools, and the Explain Experimental Control language available to application software. All application functions are accessed through the Framework menus. One Framework can be shared by several Gamry Instruments applications.

You can run a standard test from any Framework applications at the click of a button. When a standard test isn't enough, you can create new tests using the Explain™ script language. Data manipulation and display are done in Gamry's Echem Analyst via user accessible scripts.

The Gamry Framework is not useful without some sort of application program. In theory, a customer can write his own unique application and never purchase any Gamry Instruments' application programs. However, in practice, we expect all Framework systems to incorporate one or more Gamry Instruments' applications, such as the DC105 DC Corrosion Measurement System or the EIS300 EIS System.

DC105 Product Description

The DC105™ provides a modern set of tools for DC electrochemical corrosion testing. It offers a unique combination of flexibility, power, and ease of use.

The DC105 includes techniques for measuring the rate of general corrosion, determining corrosion mechanism, measuring the susceptibility to localized corrosion, and measuring galvanic corrosion rates.

Standard tests in the DC105 include:

- Polarization Resistance – used for non-destructive corrosion rate testing
- Tafel Analysis – more accurate corrosion rate measurements
- Potentiodynamic - used in the study of corrosion mechanisms
- Cyclic Polarization – measures pitting tendencies in passive systems
- RpEc Trend – measures corrosion rate versus time curves, useful in inhibitor testing
- Galvanic Corrosion – measures interactions between dissimilar metals
- Critical Pitting Potential - This technique is Gamry's implementation of *ASTM F746 Standard Test Method for Pitting or Crevice Corrosion of Metallic Surgical Implant Materials*.

The DC105 also includes other tests too numerous to be listed here.

PHE200 Product Description

The PHE200 Physical Electrochemistry system is used in the study of electrochemical systems. Applications for the PHE200 include:

- Battery Development
- Catalysis Research
- Sensor development
- Determination of reaction mechanisms, and rate and equilibrium constants

The PHE200 offers a number of traditional techniques including:

- Cyclic Voltammetry
- Linear Sweep Voltammetry
- Chronopotentiometry
- Chronoamperometry
- Chronopotentiometry

The PHE200 also includes a method for uncompensated resistance measurement via a limited EIS technique.

Gamry's Echem Analyst offers a wide selection of tools for display and manipulation of PHE200 data. Peak finding, peak height measurement, integration, and $t^{1/2}$ plots are a few highlights of the Echem Analyst's capabilities.

PV220 Product Description

The PV220 Software is an excellent companion to the PHE200. It uses pulsed electrochemical techniques with greatly enhanced sensitivity when compared to the PHE200 techniques. This allows electrochemical measurements to be made at very low concentrations of the electro-active species. The PV220 includes the following techniques:

- Square Wave Voltammetry
- Normal Pulse Voltammetry
- Sampled DC Voltammetry
- Differential Pulse Voltammetry
- Reverse Normal Pulse Voltammetry
- Generic Pulse

Another use for the PV220 is trace chemical analysis. All of the voltammetric techniques also have a Stripping mode which further enhances sensitivity when used for chemical analysis.

The PV220 is designed to operate with solid, rotating, or mercury electrodes.

EIS300 Product Description

The EIS300 EIS system provides a comprehensive set of tools for Electrochemical Impedance Spectroscopy.

As in all modern EIS systems, the EIS300 uses a computer to automate EIS data acquisition and assist in data analysis. The EIS300 software operates under the Gamry Framework, which in turn operates under the Microsoft Windows® operating environment.

The EIS300 can measure impedance from 10 µHz to 300 kHz with no additional hardware. A built-in signal generator on the potentiostat applies a sine wave to the cell and the potentiostat's internal A/D converters measure the cell's response.

Unlike most other EIS software, the EIS300 can operate in a variety of control modes. A novel hybrid galvanostatic/potentiostatic mode is available beyond the common potentiostatic and galvanostatic modes. This hybrid mode is particularly useful when the cell's open circuit potential is not stable.

CPT 110 Product Description

The CPT110 System includes two techniques that can be used in the study of temperature dependent pitting phenomena. Both techniques are highly automated, with the computer completely controlling the data acquisition process.

Critical Pitting Temperature

The Critical Pitting Temperature (CPT) experiment determines the temperature at which pits are initiated in a given environment. A temperature controller controls the temperature of the cell. Both a Gamry Instruments, Inc. temperature controller, the TDC2, and Neslab™ temperature baths are supported.

The CPT110 System software sets the temperature of the controller via an RS232 connection.

The actual CPT test involves a sequence of current versus time curves recorded at a specific test potential. The temperature is increased by a known amount prior to each curve acquisition. The CPT110 ends the experiment when the current versus time curve reaches a user defined current limit or the temperature reaches its limit.

Cyclic Thermammetry

Cyclic Thermammetry (CT) is a technique analogous to cyclic polarization. However, instead of recording current versus potential, a current versus temperature curve is recorded at a fixed potential. Cyclic Thermammetry can measure critical pitting temperatures much more rapidly than the Critical Pitting Temperature technique.

Gamry Instruments also has other techniques useful in testing for localized corrosion. Gamry Instruments' DC105 DC Corrosion Measurement System includes a technique called Cyclic Polarization. This is the standard laboratory technique used to detect localized corrosion.

Pitting susceptibility of biomedical implants can be measured using the Critical Pitting Potential (CPP) technique. This technique is Gamry's implementation of *ASTM F746 Standard Test Method for Pitting or Crevice Corrosion of Metallic Surgical Implant Materials*. In Rev 4, the CPP technique is available in the DC105 DC Corrosion Measurement System.

The CPT110 has many applications. It can be used for materials selection, inhibitor evaluation or for basic studies of the pitting process. Examples of CPT110 customers include the petroleum and chemical process, biomaterials, paper processing, and nuclear industries. Any industry involving high tech metals exposed to seawater or brine should find the CPT110 useful.

EN120 Product Description

Noise in electrochemical corrosion measurements is common, showing up in both the current and voltage signals.

The EN120 is Gamry's original system for electrochemical noise measurement. For most applications, it has been replaced by the ESA400, which offers both more accurate data acquisition and more extensive analysis tools. The EN120 is still useful when a) multiplexed operation is required or b) customization of experiments using Explain is desired.

The EN120 uses a very simple method to measure noise. Periodically, short blocks of current or current and potential data are acquired using the potentiostat's internal A/D converter. Both the length of the data block and the point density of the block are controlled by the user. Typically, each block will be 20 seconds long and will contain 100 data points.

The user also controls the time spacing between blocks and the total test time. Typical values are one block every 10 minutes for 24 hours.

The EN120 tests use a simple de-trended RMS calculation on each data block to get an estimate of the noise level during the block. This block/mean calculation repeated periodically builds up a noise versus time curve.

FC350 Product Description

The FC350 Fuel Cell Monitor allows you to measure the electrochemical impedance of an operating fuel cell. It can also be used to measure the impedance of high current primary and secondary batteries.

As in all modern EIS systems, the FC350 uses a computer to automate EIS data acquisition and assist in data analysis. The FC350 uses the same research-grade analysis tools as the EIS300, so you can wring all the available data from the impedance spectrum of your fuel cell.

The FC350 does not operate with Gamry standard potentiostats. Instead, it uses an electronic load or programmable power supply in a constant current mode to control the fuel cell (or battery). AC current is superimposed on the DC current drawn from the battery. It does still require hardware installed in a computer. Either the ISA based FC4 or PCI based FCI4 can be used to interface to the load.

Gamry's Labview Based Applications

Gamry currently has two applications that are not based on the Gamry Framework. The ESA400 and the VFP600 are compiled Labview applications. These applications also do not use the EChem Analyst for data display and manipulation. As such, they do not offer the flexibility available using Explain and VBA scripting.

Both the VFP600 and ESA400 do require installation of the Gamry Framework on the system. Some Framework files (primarily potentiostat drivers) are used by the Labview applications. Calibration of potentiostats can only be done using the Framework's calibration programs.

ESA 400 Product description

The ESA400 Electrochemical Signal Analyzer is designed to address both the past problems and the future needs of electrochemical noise measurements. Its primary goal is to assist in the evaluation of noise as a technique for the routine study of chemical processes by providing a convenient package for versatile data acquisition and sophisticated data analysis.

For acquisition, the ESA400 partners with any of Gamry PCI4 or PC4 family potentiostats and generates reliable noise data in potentiostatic, galvanostatic, or zero resistance ammeter (ZRA) mode. Careful attention is paid to sample continuity, acquisition rate, filtering, and auto-ranging to provide the most accurate signal representation.

Various physical and chemical processes can give rise to seemingly random low-frequency signals. These phenomena include pitting and crevice corrosion, uniform corrosion, coating failure, inhibitor activity, cracking, passive film stability, adsorption, and gas generation. The potential and/or current fluctuations from these stochastic processes, taken as a group, are referred to as electrochemical noise.

To transform the noise into information, the ESA400 provides an impressive package of signal analysis tools: blockwise statistics, Fourier and MEM frequency domain analysis, correlation analysis, histograms, and the powerful JFTA (Joint Time-Frequency Analysis). These algorithms can be used to calculate quantitative results from the data. When there is information buried in electrochemical noise, the ESA400 gives you the power to find it.

VFP 600 Product Description

The VFP600 is a general-purpose "front panel" application that allows the owner of a Gamry Instruments potentiostat to run simple experiments without any programming or complex application software.

We call it a virtual front panel because the program allows operation of the instrument as though it was a traditional potentiostat with a front panel containing knobs and dials. The user has the ability to select between potentiostat, galvanostat, and ZRA operation, set potentials or current levels, select the current range, and adjust other typical potentiostat controls.

This manual mode of operation can be used to run a number of simple long term experiments such as cathodic disbondment tests on coatings, build protective oxide layers on metal specimens, model plating processes, or perform exhaustive electrolysis for electrochemical synthesis.

In addition, the VFP600 allows the user to apply a waveform to the cell. Available waveforms include square waves, sine waves, linear ramps, and cyclic ramps.

The potentiostat's A/D converter can be used to acquire voltage and/or current data at a user selected rate. This data acquisition is synchronized with the waveform (if any) applied to the cell. The data that is recorded can be stored on a disk for later analysis.

Combining these features the user has a system that can perform many of the tests that are found in expensive applications packages for research electrochemistry and corrosion testing. This includes linear polarization tests, chronopotentiometry, chronoamperometry and cyclic voltammetry. The VFP600 does lack many of the convenience features and sophisticated analysis capabilities that justify the cost of these applications programs.

Chapter 4 –Calibration and System Checkout

About this Chapter

This chapter describes the calibration and system checkout of Gamry Instruments electrochemical test systems. Calibration is vital to the proper functioning of a Gamry Instruments system. Whenever a new potentiostat is added into a computer, it must be calibrated.

Calibration also does some system checking. Error messages seen during calibration should always be a cause for concern. If you see any errors during calibration, contact Gamry or your local Gamry representative.

The system checkout procedures also help to determine if your test system is nominally functional. A malfunctioning system will usually fail a checkout procedure. However, you should not assume that a system that works properly during a checkout procedure is fully functional - the checkout procedure is not a comprehensive system test.

Much of this information in this chapter takes the form of step-by-step procedures.

> NOTE: The material in this chapter is not relevant to FC350 Fuel Cell Test systems with an FCI4 or FC4 Fuel Cell Interface. If you have an FC350 system, use the calibration procedure described in the FC4 or FCI4 Users manual.

PCI4 Family Potentiostat Calibration

This section covers calibration of a PCI4 family potentiostat (PCI4/300, PCI4/750, FAS2) with a Gamry Universal Dummy Cell 2. If you need to calibrate a PC4 family potentiostat, skip to the section labeled **PC4 Family Potentiostat Calibration**.

After you have installed your new Gamry Software, you should run the calibration routine for each potentiostat in your system. See each potentiostat's Operator's Manual for additional information concerning calibration. A step-by-step calibration procedure is given below.

PCI4 Family Calibration Procedure

The procedure to calibrate a Gamry PCI4 family potentiostat is:

1. Run the Framework.
2. From the Framework bar, select **File, Calibrate…**. A Setup dialog box will be displayed. Select the potentiostat to be calibrated by pointing to the potentiostat label and clicking the mouse button. Select **OK**.
3. A dialog box will be displayed with a description of the appropriate cell cable connections for the selected potentiostat. Different potentiostats use different cell cable connections during calibration. Make the appropriate connections as instructed by the calibration script.

   > NOTE: Calibration of a PCI4 family potentiostats requires the use of an external 2 kΩ (±0.05% tolerance) resistor, supplied with your system on the Universal Dummy Cell 2. On the Universal Dummy Cell 2 this resistor is labeled as the Calibration Cell.

NOTE: Gamry strongly recommends that you shield your calibration resistor using a Faraday Shield during calibration. The shield can be as simple as a cardboard box covered with aluminum foil. We recommend that you connect the shield to both the floating ground and earth ground leads. Of course, the cell leads must not touch the conductive part of the shield.

If you are unable to locate your Universal Dummy Cell 2 you can use a discrete 2 kΩ resistor. Be careful - this may cause errors, since the calibration script in Revision 4.2 checks for DC accuracy. Contact Gamry Instruments if you are unable to locate a suitable resistor or if you see errors.

Select **OK** once you have made the cell cable connections.

4. At this point, many calibration tests will be run, each tuning a specific parameter on the potentiostat. Calibrating one potentiostat can take as long as 10 minutes depending upon the type of potentiostat. Most calibration times are less than 5 minutes.
5. Repeat this process for each potentiostat in your system.

Failures in DC Calibration – PCI4 Family

Unlike previous revisions of the Framework, the calibration routines in Revision 4.2 include rough checks of both potentiostatic and galvanostatic operation of the PCI4 family potentiostat.

When the calibration curve title shows “Checking Potentiostat – Applying 1 V…” the potentiostat has been set up to apply 1 volt to the 2 kΩ calibration resistor and the cell has been switched on. An error message will be displayed if the measured current is not within 10% of the ideal value (500 µA).

NOTE: An error can indicate a malfunctioning potentiostat. It can also be caused by an incorrect resistor value in the calibration cell. Older Gamry Universal Dummy Cells had a 100 ohm calibration resistor. If you calibrate a PCI4 family potentiostat with one of these older dummy cells or any resistor other than 2 kΩ this test will fail. The galvanostat mode test will also fail.

When the calibration curve title shows “Checking Galvanostat – Applying 250 uA…” the instrument has been switched to galvanostat mode with an applied current of 250 µA and the cell has been switched on. An error message will be displayed if the measured voltage is not within 10% of the ideal value (500 mV).

PCI4 Family – When do You Need to Calibrate?

Potentiostat calibration is only required infrequently. You should recalibrate under the following circumstances:

- You are installing a potentiostat card set into a new computer or moving a card set into a different computer. The potentiostat should be calibrated in the new machine.
- It has been about one year since your last calibration.
- Your potentiostat has been serviced.
- You notice breaks or discontinuities in the data curves recorded with your system. This includes sharp changes in EIS phase.
- You have replaced your "GAMRY.INI" file.

PC4 Family Potentiostat Calibration

This section covers calibration of a PC4 family potentiostat (PCI4/300, PCI4/750, FAS2) with a Gamry Universal Dummy Cell. If you need to calibrate a PCI4 family potentiostat, return to the section labeled **PCI4 Family Potentiostat Calibration** (found before this section).

After you have installed your new Gamry Software, you should run the calibration routine for each potentiostat in your system. The calibration procedure may differ slightly for different Gamry Instrument's potentiostats. See each potentiostat's Operator's Manual for further details. A quick reference calibration procedure is given below.

PC4 Family Calibration Procedure

The procedure to calibrate a Gamry Potentiostat is:

1. Run the Framework.
2. From the Framework bar, select **File, Calibrate…**. A Setup dialog box will be displayed. Select the potentiostat to be calibrated by pointing to the potentiostat label and clicking the mouse button. Select **OK**.
3. A dialog box will be displayed with a description of the appropriate cell cable connections for the selected potentiostat. Different potentiostats use different cell cable connections and may even use different dummy cells during calibration. Make the appropriate connections as instructed by the calibration script.

   NOTE: Calibration of a PC4 family potentiostats requires the use of an external 100 Ω (±1% tolerance) resistor, supplied with your system on the Universal Dummy Cell. On the Universal Dummy Cell this resistor is labeled as the Calibration Cell.

   NOTE: Gamry strongly recommends that you shield your calibration resistor using a Faraday Shield during calibration. The shield can be as simple as a cardboard box covered with aluminum foil. We recommend that you connect the shield to both he floating ground and earth ground leads. Of course, the cell leads must not touch the conductive part of the shield.

4. If you are unable to locate your Universal Dummy Cell, you can use a discrete 100 Ω resistor. However, this may cause errors, since the calibration script in Revision 4.2 does check for DC accuracy. Contact Gamry Instruments if you are unable to locate a suitable resistor or if you see errors.

   Select **OK** once you have made the cell cable connections.

5. At this point, many calibration tests will be run, each tuning a specific parameter on the potentiostat. Calibrating one potentiostat can take as long as 10 minutes depending upon the type of potentiostat. Most calibration times are less than 5 minutes.
6. Repeat this process for each potentiostat in your system.

Failures in DC Calibration – PC4 Family

Unlike previous revisions of the Framework, the calibration routines in Revision 4.2 include rough checks of both potentiostatic and galvanostatic operation of the PC4 family potentiostat.

When the calibration curve title shows "Checking Potentiostat – Applying 1 V…" the potentiostat has been set up to apply 1 volt to the 100 Ω calibration resistor and the cell has been switched on. An error message will be displayed if the measured current is not within 10% of the ideal value (10 mA).

NOTE: An error can indicate a malfunctioning potentiostat. It can also be caused by an incorrect resistor value in the calibration cell. The newer Gamry Universal Dummy Cell 2 had has a 2 kΩ calibration resistor. If you calibrate a PC4 family potentiostat with one of these newer dummy cells or any resistor other than 100 Ω this test will fail. The galvanostat mode test will also fail.

When the calibration curve title shows “Checking Galvanostat – Applying 250 µA…” the instrument has been switched to galvanostat mode with an applied current of 250 µA and the cell has been switched on. An error message will be displayed if the measured voltage is not within 10% of the ideal value (25 mV).

PC4 Family – When do You Need to Calibrate?

Potentiostat calibration is only required infrequently. You should recalibrate under the following circumstances:

- You are installing a potentiostat card set into a new computer or moving a card set into a different computer. The potentiostat should be calibrated in the new machine.
- It has been about one year since your last calibration.
- Your potentiostat has been serviced.
- You notice breaks or discontinuities in the data curves recorded with your system. This includes sharp changes in EIS phase.
- You have replaced your "GAMRY.INI" file.

DC105 System Checkout

A Universal Dummy Cell 2 is included in every PCI4 based DC105 system. One side of this dummy cell is a DC Corrosion cell that closely mimics the behavior of a corroding electrode. A short section in Gamry's Hardware Operator's Manual describes this dummy cell in detail.

Older PC4 based system included an original Universal Dummy Cell, with a DC Corrosion cell that does a poorer job of mimicking corrosion of a electrode.

> NOTE: The Universal Dummy Cell 2 is clearly marked with its full name written on its printed circuit card. The older Universal Dummy Cell does not have a numeral 2 written anywhere on the card.

In this manual, we are updating the DC105 System Checkout to use either Universal Dummy Cell. Revision 4.2 of the Gamry Framework and of Gamry's DC105 contain a special Checkout105 script designed for use with a DC Corrosion dummy cell. The old DC105 checkout, which used the calibration cell, is now incorporated into the calibration script.

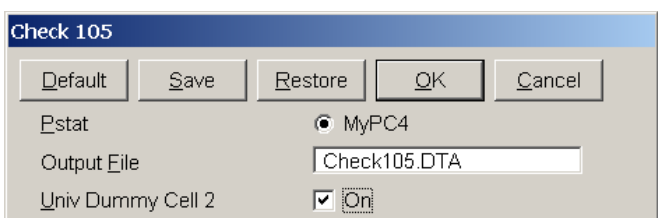
This new procedure will detect almost all possible failures in your potentiostat or cabling. The old procedure was far less comprehensive in its error detection. If your DC105 system gives good results using this procedure, you can be fairly confident that it is working properly.

The checkout procedure records a Tafel curve on the DC Corrosion dummy cell using a special Check105 script. Current Interrupt iR compensation is turned on. The checkout procedure is:

1. Run the Framework application.
2. From the Framework Menu bar, select **Experiment**, **Named Script**... In the resulting dialog box, there will be a box displaying the names of experimental scripts. Select "Check105". Select **Open**.
3. A dialog box will the shown, allowing you to choose which potentiostat you are testing, the name of file that will save the test curve, and the type of dummy cell you will use. See Figure 4-1.

   Uncheck the box next to **Univ Dummy Cell 2** if you need to use an original Universal Dummy Cell.

Figure 4-1
Check105 Setup Dialog Box



4. The Check105 script will next show a message box telling you the appropriate connections from the potentiostat being tested to the dummy cell.

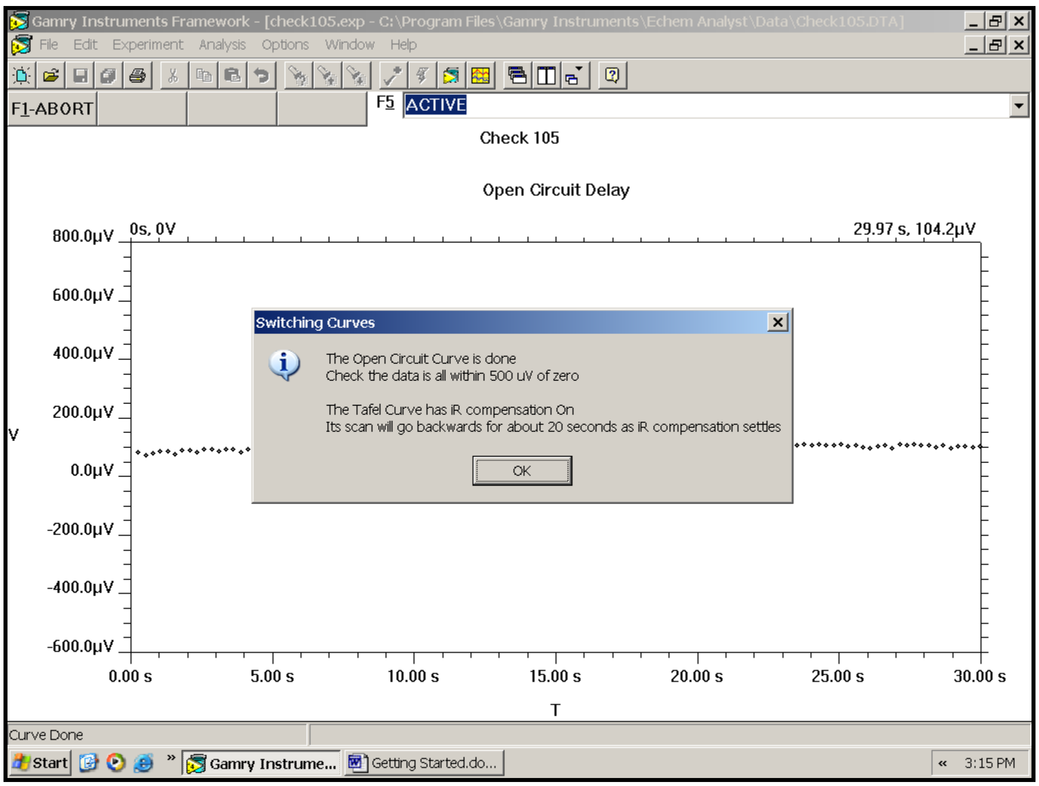
   For further information on cell connections, please consult your potentiostat's Operator's Manual.

5. If the DC Corrosion dummy cell has been used for a recent test, wait five minutes for the capacitors in the cell to discharge fully before proceeding. If the cell has been unused, you can proceed immediately.

6. The screen should switch to a graph of Open Circuit Voltage versus Time. Data is recorded for 30 seconds. A typical graph is shown in Figure 4-2. Note that a message box telling you the next step is displayed on top of the graph.

   Check that the measured voltage is approximately zero. Readings of up to ±500 µV are normal and do not indicate a problem.

Figure 4-2
Typical Open Circuit Graph for DC Corrosion Dummy Cell



7. Select Ok in the message box to go on to the next step in the checkout procedure. A Tafel curve will be recorded and displayed on the screen. The scan will take about 12 minutes.

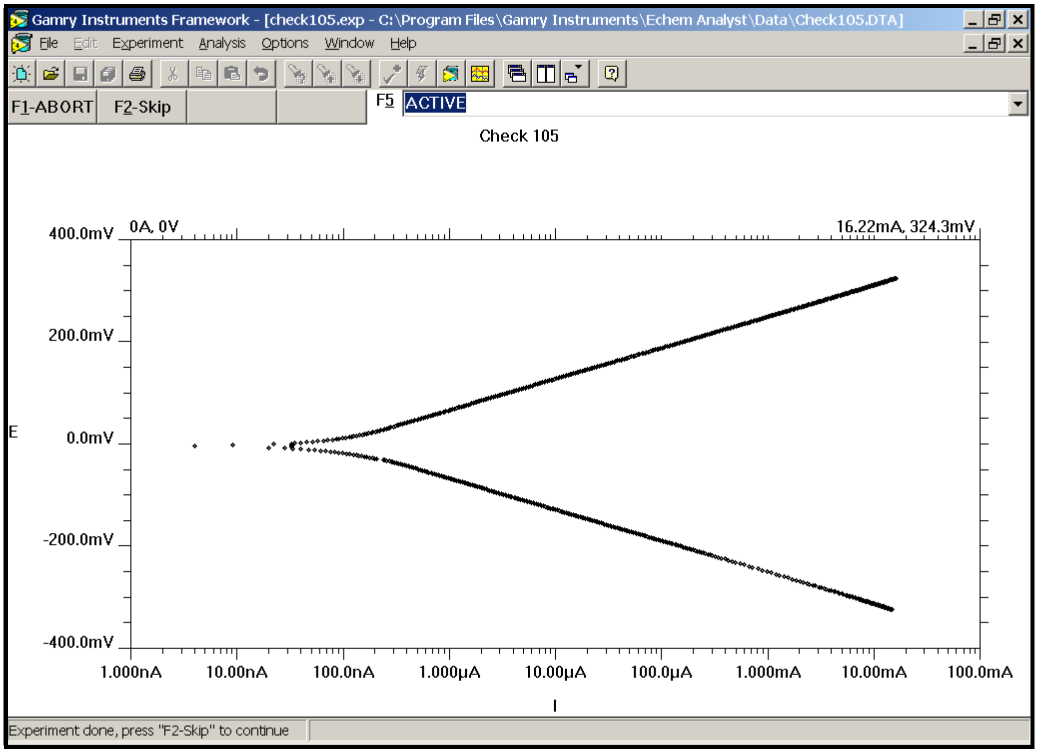
   You can get two different curves, depending on the type of Universal Dummy Cell you used. A graph of Tafel data recorded on the Universal Dummy Cell 2 is shown in Figure 4-3.

   Both the anodic and cathodic data are quite linear (plotted as log current versus potential). These data fit the Butler-Volmer relationship describing kinetically controlled corrosion very well.

   With the exception of one small gap in the data at about 300 nA, the curve is smooth and uniform. Malfunctioning systems can show very different behavior, including wide bands in the

curve, steps in the current that exceed 0.1 decade, failure to exceed 10 mA, and a left side peak that is not near zero volts.

Figure 4-3
Typical Tafel Data for the Universal Dummy Cell 2

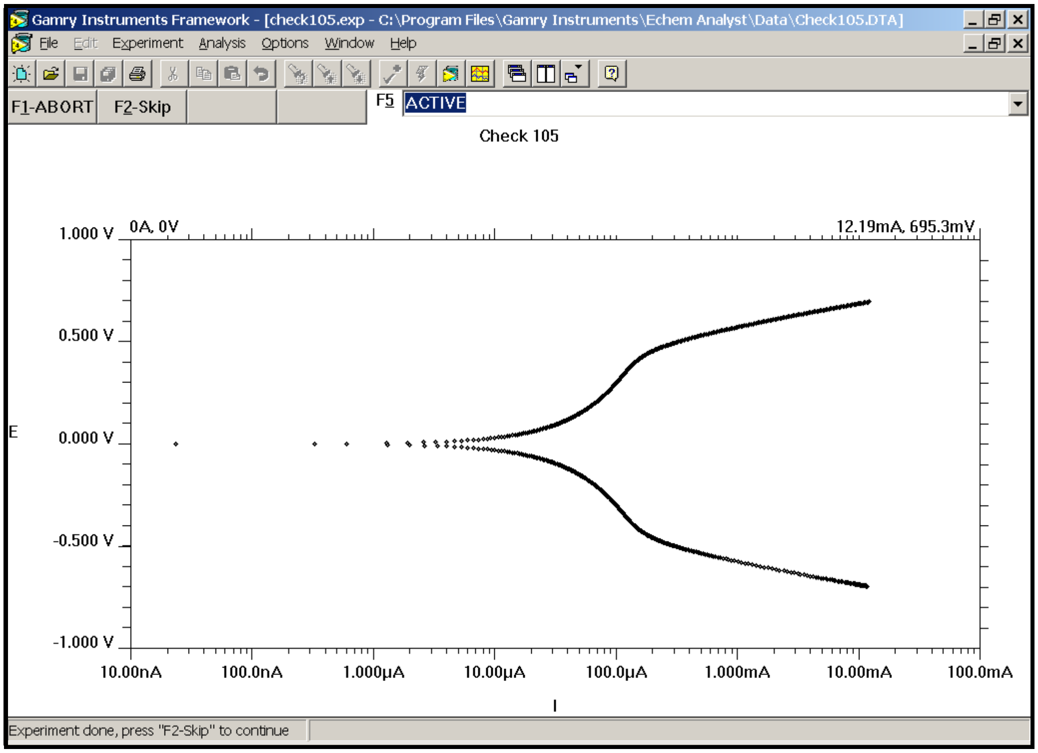


A graph of Tafel data recorded on the older Universal Dummy Cell is shown in Figure 4-4. Note that the voltage limits used for the scan were automatically widened when the older cell was selected.

The differences between the dummy cells are quite dramatic. With the older cell, the anodic and cathodic data show a linear portion (plotted as log current versus potential), but they show a great deal of curvature near zero volts. These data do not fit the Butler-Volmer relationship well.

The curve in Figure 4-4 is smooth and uniform. Malfunctioning systems can show very different behavior, including wide bands in the curve, steps in the current that exceed 0.1 decade, failure to exceed 10 mA, and a left side peak that is not near zero volts.

Figure 4-4
Typical Tafel Data for the Universal Dummy Cell



8. If you have a multiple potentiostat system, repeat steps 3 through 5 for all the other potentiostats in your system.

If you can perform all the above steps correctly, your installation checks out OK.

If you cannot, double-check the Framework and DC105 Installations. If you get a message stating that the DC105 is not authorized for use with your potentiostat, please rerun the Framework installation and double check your authorization codes.

If you cannot figure out what is wrong, contact us as soon as possible. In most cases, we will be able to diagnose your problem over the phone or via Email.

EIS300 System Checkout

You will run a simple experiment using the EIS Dummy Cell provided with the EIS300 system.

> NOTE: In all but a few very old systems, the EIS Dummy Cell is on one side of a Gamry Universal Dummy Cell. The EIS Dummy Cell is the same on both the Gamry Universal Dummy Cell and the Universal Dummy Cell 2.

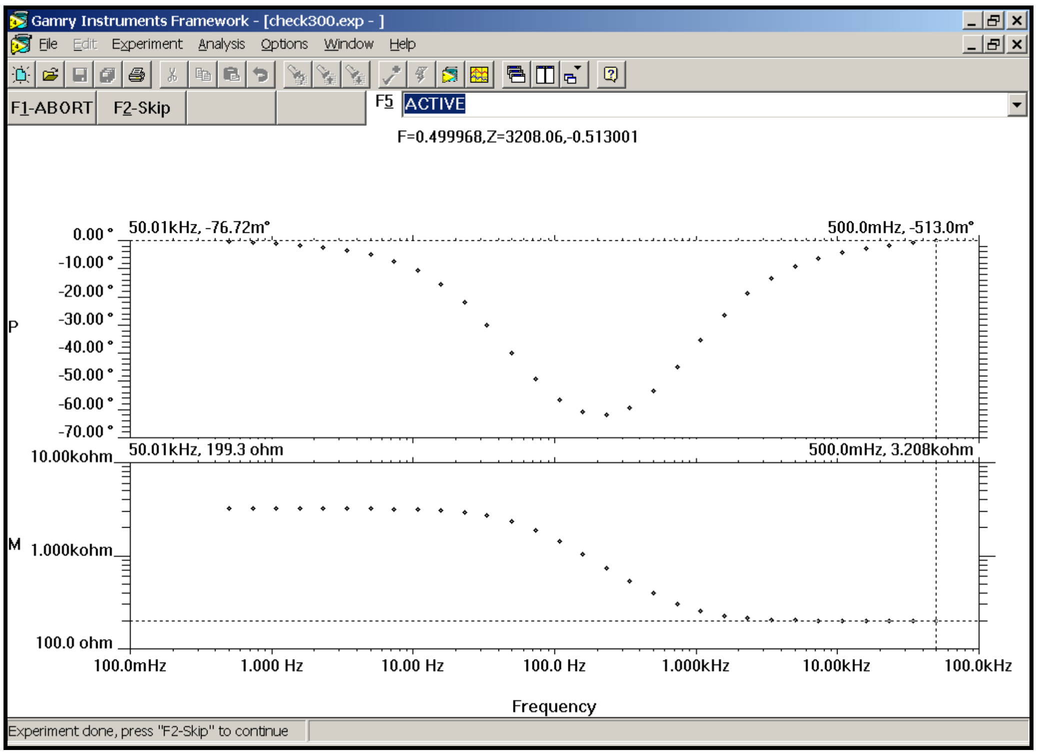
The checkout procedure is:

1. Connect the cell cable(s) of the potentiostat to the EIS Dummy Cell.
2. Run the Framework application.
3. From the Framework Menu bar, select Experiment, Named Script... In the resulting dialog box, there will be a box displaying the names of experimental scripts. Select "Check300". Select Open.

4. In the resulting dialog box, select the Potentiostat you wish to test. Select **Ok**.
5. The EIS300 will run a potentiostatic EIS sweep on the dummy cell. The sweep is from 50 kHz to 0.5 Hz at 8 data points per decade.

   During the EIS sweep, the computer screen should switch to a graph of Impedance versus Frequency. A typical graph for the AC Dummy Cell is shown in Figure 4-5. If your graph is similar to the sample figure, your EIS300 System is nominally functional.

Figure 4-5
Typical Graph for the Check300 Script using an EIS Dummy Cell



7. If you have a multiple potentiostat system, repeat steps 4 through 6 for all the other potentiostats in your system.

If you can perform all the above steps correctly, your installation checks out OK. If you cannot, double-check the Framework Installation.

If you get a message stating that the EIS300 is not authorized for use with a potentiostat, please rerun the Framework Installation and double check your authorization codes. If you cannot figure out what is wrong, contact us as soon as possible. In most cases, we will be able to diagnose your problem over the phone or via Email.

CPT110 System Checkout

The final step in a CPT110 system configuration is a test that the system has been installed properly. The following procedure can be used to test a system based on a TDC1 or TDC2 temperature controller, or a Neslab temperature bath.

Before trying a checkout on a Neslab bath, please make sure it is in RS232 control mode and that it is equipped with a remote temperature sensor. The CPT110 software will automatically set up the Neslab bath so that remote temperature sensing is enabled.

To test the operation of the system, you run a simple checkout script provided with the CPT110 software. The name of this script is "Check110.exp". Use the following procedure to check the system:

Note: At each warning prompt, you will have to hit the OK button using either the mouse or the Enter key to proceed to the next step.

1. Hook up an RTD probe to the controller and turn on the controller's power. After a few seconds, the upper display should register the temperature of the RTD. Insert the probe into your electrochemical test cell. The cell may contain plain water. It must be equipped with a heater.
2. Start up Windows and Gamry Framework.
3. Hook up the cell heater and cooling lines, or if the unit is to be used with a heating bath, make the rear panel connections to the bath.
4. From the Framework Menu bar, select **Experiment**, **Named Script**... In the resulting dialog box, there will be a box displaying the names of experimental scripts. Select "Check110". Select **Open**.
5. The script will now set the controller set point to the process temperature plus 5°C. The lower display should register the change. (TDC) Watch the upper display on the TDC1 or TDC2 or the main display on the Neslab. It should report increasing cell temperatures. Watch the controller and verify that the heat control is cycling. If you don't wish to wait for the full temperature rise, select **F2-Skip** to continue to the next test.
6. The script will now set the controller set point to the original process temperature. The lower display should register the change. Watch the upper display of the TDC1 or TDC2 or the main display on the Neslab. It should report decreasing cell temperatures. If you don't have a cooling device on your cell, this may take a while. Check that the cooler is functioning. If you don't wish to wait for the full temperature decrease, select **F2-Skip** to go to the next test.
7. If your CPT110 system includes a TDC1 Temperature Controller, its Auxiliary outputs will now be tested.

   Plug in a line voltage test device into Auxiliary 1 outlet. A desk lamp works fine. At the prompt, hit **OK**. The device should turn on. Check that Auxiliary 2 is not affected. At the next prompt, hit **OK**. The device should turn off. Again check that Auxiliary 2 is not affected.

   Plug in a line voltage test device into Auxiliary 2 outlet. At the prompt, hit **OK**. The device should turn on. Check that Auxiliary 1 is not affected. At the next prompt, hit **OK**. The device should turn off. Again check that Auxiliary 1 is not affected.

This completes the system checkout.

You will need to tune your temperature controller for use with a specific system. See the temperature controller Operator's Manual for details concerning tuning. If you were not able to complete this checkout, please check your CPT110 software installation and your temperature controller and heater hardware installation.

If you get a message stating that the CPT110 is not authorized for use with a potentiostat, please rerun the Framework Installation and double check your authorization codes. If you cannot figure out what is wrong, contact us as soon as possible. In most cases, we will be able to diagnose your problem over the phone.

Appendix A – COM Ports

ECM8 and TDC2 COM Ports

Microsoft Windows supports up to 8 COM ports, addressed as COM1 through COM9. Many AT compatible computers have two COM ports as "standard equipment". Additional COM ports can be added with expansion cards.

A computer with two COM ports is likely to have the two COM ports assigned as COM1 and COM2. Be careful though. The port assignments are generally selectable. It is not unusual to find that one of the COM ports has been reassigned as COM3.

The ECM8 and the TDC2 both require a COM port. Additional information concerning COM port configuration can be found in their User's Manuals.

If you find that you cannot communicate with a Gamry supplied RS232 device, please contact us via phone or Email for assistance.

CPT110 Neslab Support

The CPT110 software supports Neslab temperature baths. The supported models are the RTE-111, 211, 221 and EX-111, 211, 221, 411 and 511. The remote sense should be used so the temperature of the cell is being controlled rather than the temperature of the bath itself.

The Framework Installation Wizard will modify the GAMRY.INI and create a [TDC_n] section like the one below.

```
[TDC_1]
LABEL=NesLab
TYPE=3
PORT=1
MODE=COM1:9600,N,8,1
```

The PORT and MODE lines will reflect the COM port actually used (1-4). The TYPE line will always be a 3 for a Neslab controller.

Use the supplied null modem cable, connect the Neslab RS-232 port to the computer.

Using the supplied adapter, connect the external RTD probe to the Sensor port on the Neslab. The software will automatically tell the Neslab to use the remote sensor. If you do not have a remote sense probe connected to the Neslab, you will need to make a change to one of the scripts included with the CPT110 System. In the script CPT110.EXP, located in the Scripts subdirectory, there is a line which looks like:

global RemoteSense = 1 ; 1 = On, 0 = Off (Used by NesLab)

The default is RemoteSense = 1, which means an external probe is connected to the Neslab. If you do not have a probe connected, you need to change this line so RemoteSense = 0. If you do not change this line, you will get an error when trying to read a temperature from the Neslab.

Before the Gamry Instruments' potentiostats can talk with the Neslab, it must first be placed into RS232 control mode. To do this, switch on the main power of the Neslab using the toggle switch on the side of the control panel. After the main power switch has been turned on, turn on the control panel of the Neslab by pressing the "soft" On/Off switch in the lower left hand corner of the control panel.

After turning on the Neslab, press RS232 (RS232 led flashes) and then ENTER (RS232 led lights continually). If you don't press ENTER fast enough, the RS232 led goes out. If the RS232 led isn't on, the software won't work.

Run "Check110.exp" to verify that communications work. F2-Skip will terminate waiting for the temperature increase/decrease steps early. The live temperature display demonstrates working RS-232 communication.

Appendix B – PC4 I/O Addresses and Interrupts

The software described in this guide can operate with a PC4 family potentiostat. PC4 family potentiostats are all legacy ISA devices. A legacy device does not use Plug and Play protocols to assign computer resources to the device.

As a result, setting up a computer containing a PC4 does involve some work beyond simply plugging in the card. This Appendix is an attempt to give you some background to make this job easier.

I/O Addresses

One resource needed by the PC4 is 32 bytes of I/O register space. This space must be assigned to an open area within the computer's I/O address space. The total computer I/O space is 1024 bytes long. This manual (and Windows itself) uses a C programming language convention to describe addresses. All addresses are in hexadecimal and are preceded by 0x. When two devices both try to use the same I/O space, it is referred to as an address conflict. Generally both devices that are in conflict fail!

The beginning address of the PC4's I/O address is referred to as the Base Address. The PC4 can use 4 different base addresses, as seen in this table.

Base Address	Address Range
0x120 (default)	0x120-0x13F
0x140	0x140-0x15F
0x220	0x220-0x23F
0x240	0x240-0x25F

A DIP-switch on the PC4 Controller Card is used to set its Base Address. In most cases, you can leave the base address set to 0x120, since the address space between 0x120 and 0x13F is open on most computers.

Up to four PC4 family potentiostats can share one Base Address. In this case, each potentiostat is assigned a different Board Number. If the base address being shared is 0x120, Board 1 uses the address range between 0x1120 and 0x113F, Board 2 uses 0x2120 to 0x213F, Board 3 uses 0x4120 to 0x413F and Board 4 uses 0x8120 to 0x813F.

You can check for address conflicts using your computer's Device Manager, described in a later section of this appendix.

An error message that says something like:

Potentiostat not Found

is symptomatic of an address conflict. If you get an error like this when the Gamry Framework is started, examine the settings in the Device manager to find the conflict, and change the address settings to eliminate that conflict. Contact Gamry if you need help!

IRQs

Another resource needed by the PC4 is an IRQ (interrupt line). There are 16 possible IRQs in an AT compatible computer. In most computers, very few of these are available for use by expansion cards such as the PC4. The PC4 is an ISA interface card, which places additional restrictions on its possible IRQ assignments.

I/O devices on the PCI can share IRQ levels. You will often see a PCI network card assigned to the same IRQ level as a PCI sound card. PCI interrupt levels are assigned during boot up of the computer. The Windows Plug and Play manager is responsible for these assignments.

In general, ISA cards cannot share IRQs. A PC4 will not operate properly if it is assigned to the same IRQ as a sound card, network card, or IEEE488 Interface card. This is true even if the other IRQ is assigned to a PCI bus I/O device.

There is one very important exception to this rule about sharing IRQ assignments on the ISA bus. A system containing multiple PC4s can have all the PC4s share one IRQ level. However, this level cannot be shared with any non-Gamry device.

Unlike I/O addresses, you can assign an IRQ to a PC4 without changing DIP-switch settings. One of four possible IRQ levels can be assigned – 5, 10, 11 or 15.

The IRQ level is assigned during Framework Setup. The Setup program looks at for an open IRQ at one of its four possible settings. If it finds an open IRQ, it assigns the PC4 to that IRQ level.

The assignment fails if no valid IRQ level is available when Setup is run. In this case, the PC4 is assigned to IRQ Level 15, even though this level conflicts with an existing IRQ assignment.

Most modern computers have a mechanism that can reserve an IRQ levels for use with ISA legacy devices like the PC4. A reserved level cannot be assigned to a PCI device in the Plug and Play process. IRQ levels can be reserved using either the computer's BIOS setup or the Windows Device manager. The BIOS setup is more complicated but more reliable.

Reserving IRQ Levels Using the BIOS Setup

Most computer BIOS setup routines allow IRQ levels to be reserved for use by legacy devices. The details on how to do this vary depending on the BIOS being used and user interface in the BIOS setup.

In all cases, you need to enter the BIOS setup by entering a key or keys during power-on-self-test (POST) of the computer. The computer display will often tell you which key or keys you must hit. Common keys used for BIOS setup include ESC, DEL and F2.

Once you are in the BIOS setup, there will be a page labeled Plug N Play, PnP, or PCI manager. IRQ levels are reserved on this page. Sometimes there is a table of IRQ assignments directly visible on the page, sometimes there isn't.

If you don't see an IRQ assignment table, there should be a setting that will make it appear. The name of this setting varies. One such setting name is "Resources Controlled By: Auto". Switch this setting to Manual and a table of IRQ levels appears.

Look at the table of IRQ levels. Many of them have a setting of PNP, PCI or Automatic, indicating that the Windows Plug-n-Play manager will assign that IRQ to a device when the computer boots. Chose one of the PC4 compatible levels (5 and 10 are usually best) and switch its setting to Reserved (in some BIOS Setups the term for this is Legacy or ISA). The Plug-n-Play manager does not assign a Reserved IRQ to a device. That IRQ is therefore available for use by a PC4.

Leave the BIOS setup, saving the settings in CMOS memory and reboot.

If you cannot get your BIOS to reserve an IRQ level – contact Gamry's tech support staff. We can help you to get this working!

Windows Device Manager

The Windows Device Manager is very useful in resolving addressing and IRQ level conflicts in PC4 based electrochemistry systems. In Windows terminology, IRQ levels and I/O addresses are "resources" that can be assigned to a specific I/O device. You use the Device Manager examine the systems resource assignments and to modify assignments for both PC4s and non-Gamry devices.

The Device Manager shows devices that are configured properly as a simple icon. Devices that have a problem in their configuration have yellow highlighted exclamation mark added to their icon.

Details of the Device Manager behavior differ depending on the Windows version being used on your computer.

Starting the Device Manager in Windows 98 or Windows ME

This section is relevant to Windows 98 and Windows ME. The procedure used to open the Windows 2000 or Windows XP Device Manager is described in the next section.

The Device Manager can be accessed from the Windows Start menu. Select **Start, Settings, Control Panel**. This opens a folder of Windows applications. One of these applications is labeled **System**. Select this application.

In Windows 98 and Windows ME, the System application is organized under four tabs. One of these tabs is the **Device Manager**. Select this tab to start the device manager.

You can check overall resource usage by clicking the right mouse button on the first (Computer) entry in the Device Manager. Select **Properties** in the resulting menu. You have a choice of viewing IRQs or I/O addresses.

Starting the Device Manager in Windows 2000 or Windows XP

This section is relevant to Windows 2000 and Windows XP.

The Device Manager can be accessed from the Windows Start menu. Select **Start, Settings, Control Panel**. This opens a folder of Windows applications. One of these applications is labeled **System**. Select this application.

You will see a page of option buttons. Select **Device Manager**.

You can look at overall resource usage by selecting **View** on the menu bar. Both IRQ and I/O address usage can be seen.

PC4 Devices in the Device Manager

A PC4 potentiostat, because it can share Base Addresses and IRQ levels with other PC4s, is a more complex device than a simple I/O card. A PC4 appears in the Device Manager as <u>three</u> Gamry devices.

The first device is the Gamry IRQ Manager. There is one IRQ Manager for each IRQ level used by Gamry devices. The only resource needed by the IRQ Manager is an IRQ Level. As discussed above, the IRQ level assigned to the Gamry IRQ Manager can be shared among several PC4s, but it cannot be shared with other non-Gamry devices.

The second device is the Gamry Memory Manager. This manager handles requests for system memory made by the PC4 driver and the Gamry software. There can only one Gamry Memory Manager in your system, regardless of the number of potentiostats. The Gamry Memory Manager does not need any system resources.

The third device is the Gamry PC4 Potentiostat. There is one PC4 Potentiostat software device for each physical potentiostat in the system. Each Potentiostat requires 32 bytes of I/O address space as a resource. This I/O space cannot overlap with the I/O space of any other device.

I/O Addresses in the PC4 device are made up of the Base Address and an offset derived from the PC4's Board Number. Board 1 is at 0x1000 plus the Base Address, Board 2 is at 0x2000 plus the Base Address, Board 3 is at 0x4000 plus the Base Address, and Board 4 is at 0x8000 plus the Base Address.

PCI4 Devices in the Device Manager

A PCI4 potentiostat is a more complex device than a simple I/O card. A PCI4 appears in the Device Manager as <u>two</u> Gamry devices.

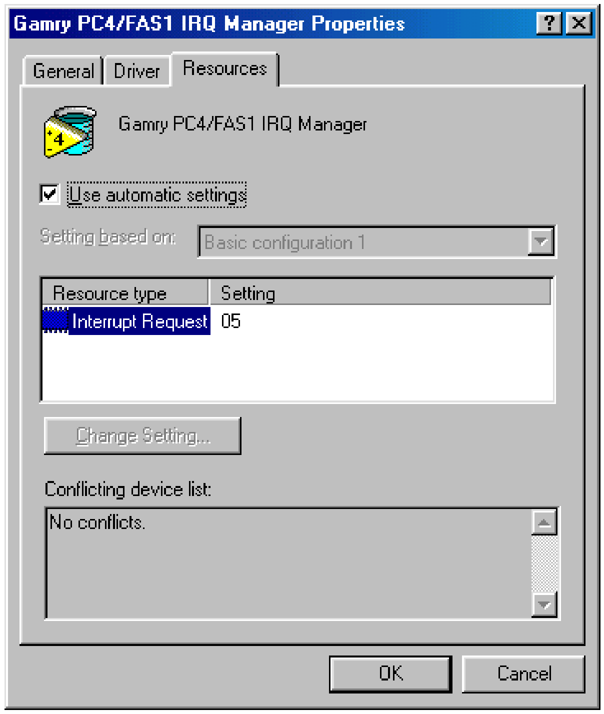
First device is the Gamry Memory Manager. This manager handles requests for system memory made by the PCI4 driver and the Gamry software. There can only one Gamry Memory Manager in your system, regardless of the number of potentiostats. The Gamry Memory Manager does not need any system resources.

The second device is the Gamry PCI4 Potentiostat. There is one PCI4 Potentiostat software device for each physical potentiostat in the system. Each Potentiostat requires two memory resources and one I/O resource.

Changing PC4 IRQ Settings Using the Device Manager

Load the Device Manager. On this list of devices, select the Gamry PC4 IRQ manager. A Window similar to the next Figure should appear.

Gamry IRQ Manager in Device Manager



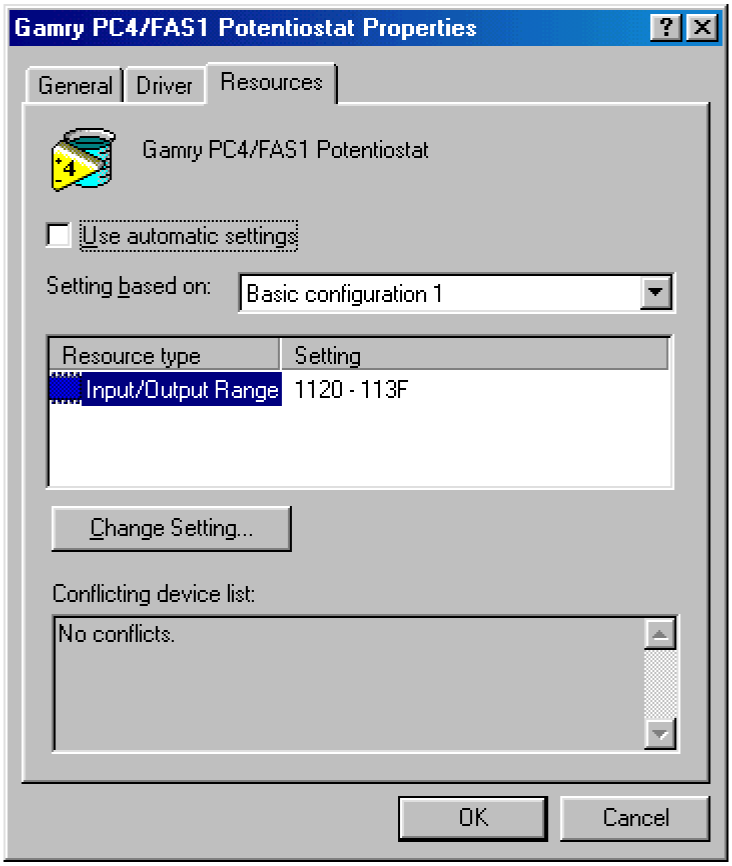
In this Figure, the **Resources** tab has been selected. Notice several important areas on this form. The **Resource Field** shows an entry for an Interrupt Request, currently set to IRQ 5. The **conflicting device list** box shows that Windows does not see any conflicts over this resource. The setting is based on a configuration identified by a number (configuration 1).

You can change the IRQ assignment as follows: Remove the check on **Use automatic settings**, and then select a different **Basic Configuration**. When you do, the Interrupt Request will change to 5, 10, 11 or 15. There may or may not be conflicts at this new setting. Once you are satisfied with the setting, select **Ok**. Reboot your computer to make sure that the change takes effect.

Changing PC4 Address Settings in the Device Manager

Load the Device Manager. On this list of devices, select a Gamry PC4 Potentiostat device. A Window similar to the next Figure should appear.

Gamry PC4 Potentiostat in the Device Manager



In this Figure, the **Resources** tab has been selected. Notice several important areas on this form. The **Resource Field** shows an entry for an Input Output Range, currently set to 1120-113F. The **conflicting device list** box shows that Windows does not see any conflicts over this resource. The setting is based on a configuration identified by a number (currently configuration 1).

You can change I/O address assignment as follows: Uncheck **Use Automatic Settings** if it is checked. Chose a different **Basic Configuration**. When you do, the Input Output Range will change. There may or may not be conflicts at this new setting. Once you are satisfied with the setting, select **Ok**. Reboot your computer to make sure that the change takes effect.

Make sure that the I/O Address settings in the Device Manager, the Base Address & Board Number settings on the PC4's Dip Switch, and the "GAMRY.INI" settings for the potentiostat all match. If all three addresses do not match, the PC4 will not function. In most cases, mismatches will create an error when the Gamry Framework or LabView based software starts up. The error message will be "Potentiostat not Found".

You should change the I/O Address settings for every potentiostat is a multiple potentiostat system.

Appendix C – Identifying Potentiostats in a Complex System

Systems containing multiple potentiostats can be a very cost and space effective solution to electrochemical testing problems. The new MultEchem™ system substantially reduces the software costs associated with buying four or more potentiostats. One computer with multiple potentiostats uses up a lot less bench space than four separate computer systems.

One potential problem – all PCI4 or FAS2 potentiostats look the same when you view the back of your computer. Its awkward to open up your computer case if you lose track of which potentiostat is Pstat1!

Revision 4.2 of the Gamry Framework has a new script "IDENTIFY POTENTIOSTATS.EXP" that you can use to help identify your PCI4 family potentiostats. It sequences through the potentiostats in your system, blinking the Cell ON LED for each potentiostat. When this script is run, the LED blinks without the cell turning On, so you can safely identify potentiostats even when they have samples attached to them.

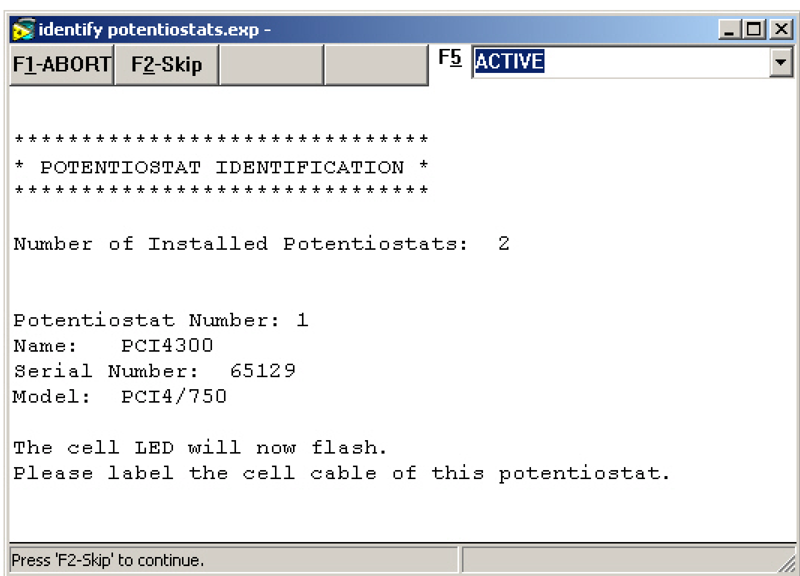
> Note: The cell LED is the only yellow LED on a PCI4 mini-panel. It is located just under the cell cable connector. You will need to look at the back of your computer to see it blink. The cell LED on an FAS2 is located on the front panel of the FAS2 pod. It is also yellow.

This script does not work with ISA based PC4 family potentiostats.

We recommend that you follow this procedure to identify your potentiostats:

1. Start the Framework Application
2. From the Framework Menu bar, select **Experiment, Named Script...** In the resulting dialog box, there will be a box displaying the names of experimental scripts. Select "Identify Potentiostats". Select Open.
3. A runner window will open up. See Figure C-1.

Figure C-1
Identifying the First Potentiostat



The text in this window starts with this self-explanatory line:

Number of Installed Potentiostats: 2

2. The next text section in the windows tells you that the current potentiostat is **Number** 1, its **Name** is PCI4300, its **Serial Number** is 65129, and it is a **Model** PCI4/750 (we made an error when we typed its **Name**). Following this are the lines:

   The cell LED will now flash.
   Please label the cell cable of this potentiostat.

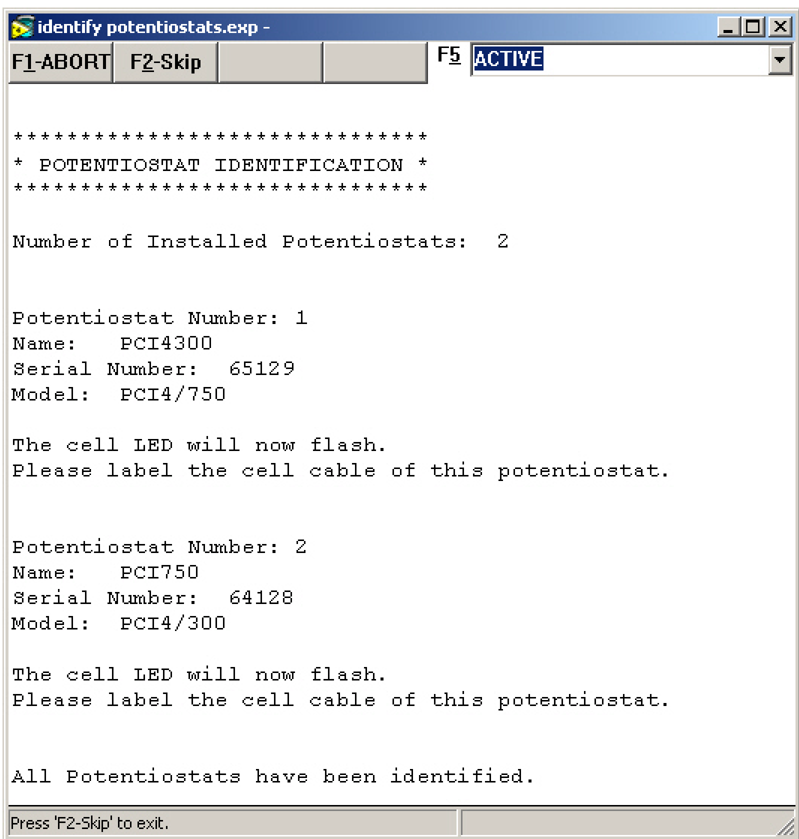
   If you look at the all the potentiostat Cell LED indicators in your system, only one is flashing (turning On and Off). This is the potentiostat labeled as Pstat1 in the "GAMRY.INI" file. As stated in the text, you should label the cell cable or the potentiostat itself now that it has been identified. We recommend that you use the potentiostats **Name** on the label, since potentiostats are identified by their **Name** in the Setup window of every experiment.

   Notice the message at the bottom of the window. It says "Press F2-Skip to Continue."

3. Press **F2-Skip**. The information for the next potentiostat in the system will be displayed and its Cell LED will flash. Label it.

4. Press **F2-Skip** again. The next potentiostat will be displayed, if there are more potentiostats. This will continue for all the potentiostats in the system.

Figure C-2
All Potentiostat Identified



In our example we only have two potentiostats, so the window will display the text:

   All Potentiostats have been identified

See Figure C-2.   When you press F2-Skip a final time, the runner window will close.

Appendix D – Calibration Results Files

A Calibration Results file is generated whenever the Gamry Framework calibrates a PC4 or PCI4 family potentiostat. This text file is very useful whenever a calibration fails, because it identifies which test has failed, the measured value, and the allowed limits in that measurement.

The Calibration Results File is saved in the same Windows Folder as the Gamry data files. The Filename for the file is “Calibration Results XXXXX.txt” where XXXXX is the serial number of the controller card in the potentiostat being calibrated. Each new calibration overwrites the previous Calibration Results file, if one existed.

A typical Calibration Results file is shown below

```
Calibration Values for PCI750  - S/N# 30102
4/24/2003  12:10:00

Ich Post Offset [0]:  0.000132  (0.003) - PASSED
Vch Post Offset [0]:  5.76E-005  (0.003) - PASSED
Ich Range Offset [0]:  0.000102  (0.003) - PASSED
Ich Range Offset [1]:  0.000104  (0.003) - PASSED
Ich Range Offset [2]:  5.99E-005  (0.003) - PASSED
Ich Range Offset [3]:  0.000119  (0.003) - PASSED
Vch Range Offset [0]:  4.1954E-005  (0.003) - PASSED
Vch Range Offset [1]:  4.491E-005  (0.003) - PASSED
Vch Range Offset [2]:  6.66E-005  (0.003) - PASSED
Vch Range Offset [3]:  0.000321  (0.003) - PASSED
Ich Filter Offset [0]:  0.000251  (0.02) - PASSED
Ich Filter Offset [1]:  0.000313  (0.02) - PASSED
Ich Filter Offset [2]:  0.00023  (0.02) - PASSED
Ich Filter Offset [3]:  0.00096  (0.02) - PASSED
Vch Filter Offset [0]:  0.000476  (0.02) - PASSED
Vch Filter Offset [1]:  0.000555  (0.02) - PASSED
Vch Filter Offset [2]:  0.000525  (0.02) - PASSED
Vch Filter Offset [3]:  0.001032  (0.02) - PASSED
IE Pstat Mode Offset [0]:  0  (3.003) - PASSED
IE Pstat Mode Offset [1]:  0  (0.303) - PASSED
IE Pstat Mode Offset [2]:  0  (0.033) - PASSED
IE Pstat Mode Offset [3]:  0.046065  (0.103) - PASSED
IE Pstat Mode Offset [4]:  0.004486  (0.013) - PASSED
IE Pstat Mode Offset [5]:  9.24999E-005  (0.004) - PASSED
IE Pstat Mode Offset [6]:  0.000439  (0.0031) - PASSED
IE Pstat Mode Offset [7]:  0.000539  (0.00301) - PASSED
IE Pstat Mode Offset [8]:  0.000346  (0.003001) - PASSED
IE Pstat Mode Offset [9]:  0.000212  (0.003) - PASSED
IE Pstat Mode Offset [10]:  0.0006  (0.003) - PASSED
IE Pstat Mode Offset [11]:  6.50006E-006  (0.003) - PASSED
IE Pstat Mode Offset [12]:  0  (0.003) - PASSED
IE Pstat Mode Offset [13]:  0  (0.003) - PASSED
IE Pstat Mode Offset [14]:  0  (0.003) - PASSED
IE Pstat Mode Offset [15]:  0  (0.003) - PASSED
EL Offset [0]:  0  (0.003) - PASSED
EL Offset [1]:  0  (0.003) - PASSED
EL Offset [2]:  0  (0.003) - PASSED
EL Offset [3]:  2.05999E-005  (0.003) - PASSED
EL Offset [4]:  1.05001E-005  (0.003) - PASSED
```

```
EL Offset [5]:  1.9E-005  (0.003) - PASSED
EL Offset [6]:  4.99989E-007  (0.003) - PASSED
EL Offset [7]:  8.99989E-006  (0.003) - PASSED
EL Offset [8]:  9.50003E-006  (0.003) - PASSED
EL Offset [9]:  6.99992E-006  (0.003) - PASSED
EL Offset [10]:  1.00001E-005  (0.003) - PASSED
EL Offset [11]:  1.E-005  (0.003) - PASSED
EL Offset [12]:  0  (0.003) - PASSED
EL Offset [13]:  0  (0.003) - PASSED
EL Offset [14]:  0  (0.003) - PASSED
EL Offset [15]:  0  (0.003) - PASSED
IE Gstat Mode Offset [0]:  0  (3.005) - PASSED
IE Gstat Mode Offset [1]:  0  (0.305) - PASSED
IE Gstat Mode Offset [2]:  0  (0.035) - PASSED
IE Gstat Mode Offset [3]:  0  (0.105) - PASSED
IE Gstat Mode Offset [4]:  0.00456  (0.015) - PASSED
IE Gstat Mode Offset [5]:  0.000525  (0.006) - PASSED
IE Gstat Mode Offset [6]:  0.000098  (0.0051) - PASSED
IE Gstat Mode Offset [7]:  5.29999E-005  (0.00501) - PASSED
IE Gstat Mode Offset [8]:  4.79999E-005  (0.005001) - PASSED
IE Gstat Mode Offset [9]:  5.04999E-005  (0.005) - PASSED
IE Gstat Mode Offset [10]:  7.74999E-005  (0.005) - PASSED
IE Gstat Mode Offset [11]:  4.64999E-005  (0.005) - PASSED
IE Gstat Mode Offset [12]:  0  (0.005) - PASSED
IE Gstat Mode Offset [13]:  0  (0.005) - PASSED
IE Gstat Mode Offset [14]:  0  (0.005) - PASSED
IE Gstat Mode Offset [15]:  0  (0.005) - PASSED
Scan DAC Offset [0]:  0.00048  (0.008) - PASSED
Scan DAC Offset [1]:  0.000631  (0.008) - PASSED
Scan DAC Offset [2]:  0.001221  (0.008) - PASSED
Ach Offset [0]:  8.92E-005  (0.003) - PASSED
ZRA Scan Offset [0]:  0.001128  (0.005) - PASSED
ZRA Scan Offset [1]:  0.001262  (0.005) - PASSED
ZRA Scan Offset [2]:  0.001779  (0.005) - PASSED
Positive Feedback Offset [0]:  0.000223  (0.005) - PASSED
APPLIED DC PSTAT:  0.0005  (0.0005 +/- 10%) - PASSED
APPLIED DC GSTAT:  0.499124  (0.5 +/- 10%) - PASSED

System Passed Calibration with no warnings or errors.
```

Note that the specific potentiostat is identified in the first 2 lines of the file. The time and date the calibration occurred is also placed in the file.

Let's look at the first four lines of actual test results:

```
Ich Post Offset [0]:  0.000132  (0.003) - PASSED
Vch Post Offset [0]:  5.76E-005  (0.003) - PASSED
Ich Range Offset [0]:  0.000102  (0.003) - PASSED
Ich Range Offset [1]:  0.000104  (0.003) - PASSED
```

`Ich Post Offset` is an array of measured vales, with only the 0^{th} element defined here. The measured value was 0.000232, which is compared to zero plus or minus the number in parenthesis (0.003). It is within these limits so the measurement passed.

`Ich Range Offset` is also an array with the 0^{th} and 1^{st} elements assigned values in third and fourth line of this example.

If a test fails, the text `PASSED` is replaced with `FAILED`.

If you need to contact Gamry Instruments concerning any hardware problem, it would be helpful if you attached the Calibration Results file for the failed potentiostat to an Email describing the problem that you are seeing. The Email can be sent to your local representative, your favorite contact person at Gamry's home office or to techsupport@gamry.com.